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Europäisches Patentamt  
European Patent Office  
Office européen des brevets

⑪ Publication number:

0 125 803  
A2

⑫

EUROPEAN PATENT APPLICATION

⑬ Application number: 84302566.9

⑮ Int. Cl.<sup>3</sup>: C 07 D 211/90

⑭ Date of filing: 16.04.84

C 07 D 211/78, C 07 D 401/04  
C 07 D 405/04, C 07 D 413/04  
C 07 D 401/06, A 61 K 31/445

⑯ Priority: 27.04.83 GB 8311519  
27.04.83 GB 8311520  
27.04.83 GB 8311521  
01.10.83 GB 8326362  
15.10.83 GB 8327660  
15.10.83 GB 8327661  
18.11.83 GB 8330852  
22.12.83 GB 8334285  
22.12.83 GB 8334286  
22.12.83 GB 8334287

⑰ Date of publication of application:  
21.11.84 Bulletin 84/47

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⑱ Designated Contracting States:  
AT BE CH DE FR GB IT LI LU NL SE

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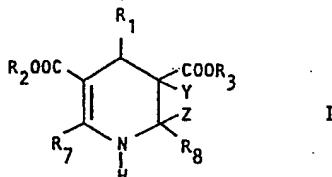
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㉑ Pharmaceutically active dihydropyridines.

㉒ There are described compounds of formula I,



in which R<sub>1</sub> represents benzofurazanyl, pyridyl or phenyl, the pyridyl or phenyl being substituted,

-COOR<sub>2</sub> and -COOR<sub>3</sub> are various ester groups,

Y and Z together form a bond, and additionally, when R<sub>8</sub> is an electron withdrawing group Y may be hydrogen and Z may be hydroxy,

one of R<sub>7</sub> and R<sub>8</sub> represents alkyl Cl to 6 and the other represents -CONR<sub>1</sub>R<sub>11</sub>; -CSNH<sub>2</sub>; -C(=NH)SR<sub>6</sub>; -S(O)mR<sub>6</sub>; phenyl optionally substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; alkyl Cl to 6 substituted by halogen; -CN; -CH<sub>2</sub>OH; -CHO or -CH(OR<sub>6</sub>)<sub>2</sub>

or R<sub>7</sub> and R<sub>8</sub> may be the same or different and each represents phenyl optionally substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; amino; alkyl Cl to 6 substituted by halogen; -CN; -CH<sub>2</sub>OH; -CHO or -CH(OR<sub>6</sub>)<sub>2</sub>, m is 0 or 1

R<sub>6</sub> is alkyl Cl to 6, and

R<sub>10</sub> and R<sub>11</sub> each independently represent hydrogen or alkyl Cl to 6, or together with the nitrogen atom to which they are attached form a 5 or 6 membered heterocyclic ring.

There are also described processes for making the compounds, and pharmaceutical, eg calcium antagonist, formulations containing them.

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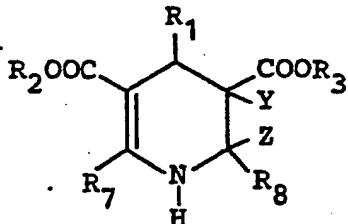
PHARMACEUTICALLY ACTIVE DIHYDROPYRIDINES

This invention relates to new compounds, methods for their preparation and compositions containing them.

A wide variety of dihydropyridines have been 5 described as being useful as pharmaceuticals and some, notably nifedipine, have been sold for this use.

We have now found a new group of pyridine derivatives which have pharmacological activity.

According to the invention we provide compounds of 10 formula I,



15

in which R<sub>1</sub> represents benzofurazanyl, pyridyl or phenyl, the pyridyl or phenyl being substituted by one or more of the groups halogen, nitro, -CN, -OR<sub>9</sub>, -S(O)<sub>p</sub>R<sub>9</sub>, or alkyl C1 to 6 optionally substituted by 20 halogen,

p is 0, 1 or 2,

R<sub>2</sub> and R<sub>3</sub>, which may be the same or different, each represent hydrogen; alkyl C1 to 6 optionally substituted by one or more of the groups halogen, cyano, 25 -XR<sub>4</sub>, -NR<sub>5</sub>R<sub>6</sub> or phenyl; cycloalkyl C3 to 8

- optionally substituted by alkyl Cl to 6; a 4, 5 or 6 membered oxygen or nitrogen containing heterocyclic ring which is optionally substituted by alkyl Cl to 6 the alkyl in turn optionally being substituted by one or more phenyl

5 groups;

$R_5$  and  $R_6$ , which may be the same or different, each represent alkyl Cl to 6 optionally substituted by phenyl,

$Y$  and  $Z$  together form a bond, and additionally, when

10  $R_8$  is an electron withdrawing group  $Y$  may be hydrogen and  $Z$  may be hydroxy,

one of  $R_7$  and  $R_8$  represents alkyl Cl to 6 and the other represents  $-CONR_{10}R_{11}$ ;  $-CSNH_2$ ;  $-C(=NH)SR_9$ ;  $-S(O)_mR_9$ ; phenyl optionally substituted by one or more

15 of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; alkyl Cl to 6 substituted by halogen; or furanyl,

or  $R_7$  and  $R_8$  may be the same or different and each represents phenyl optionally substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro;

20 amino; alkyl Cl to 6 substituted by halogen;  $-CN$ ;  $-CH_2OH$ ;  $-CHO$  or  $-CH(OR_9)_2$ ,

$X$  is O or S,

$m$  is 0 or 1,

$R_4$  is alkyl Cl to 6 or phenyl,

25  $R_9$  is alkyl Cl to 6,

•  $R_{10}$  and  $R_{11}$  each independently represent hydrogen or alkyl Cl to 6, or together with the nitrogen atom to which they are attached form a 5 or 6 membered heterocyclic ring,

5 provided that A) when  $R_7$  is alkyl Cl to 6, Y and Z together form a bond, and

    i)  $R_1$  represents benzofurazanyl then  $R_8$  does not represent  $-CF_3$ , or

    ii) when  $R_1$  represents 2-nitrophenyl, or

10 2-chlorophenyl and  $R_2$  and  $R_3$  are both ethyl, then  $R_8$  does not represent mono-chloromethyl, or

    iii) when  $R_1$  represents 3-nitrophenyl and  $R_2$  and  $R_3$  are both ethyl, then  $R_8$  does not represent unsubstituted phenyl,

15 B) when neither of  $R_7$  and  $R_8$  is alkyl Cl to 6, Y and Z together form a bond and

    iv)  $R_2$  and  $R_3$  are both ethyl then  $R_7$  and  $R_8$  are not both  $-CF_3$ , or

    v) one of  $R_7$  or  $R_8$  is amino then the other is

20 not phenyl or amino, or

    vi) one of  $R_7$  or  $R_8$  is  $-CN$ ,  $-CH_2OH$ ,  $-CHO$  or  $-CH(OR_9)_2$  then the other is not  $-CN$ ,  $-CH_2OH$ ,  $-CHO$  or  $-CH(OR_9)_2$ , and

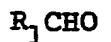
    C) both of  $R_7$  and  $R_8$  are not optionally substituted phenyl;

and pharmaceutically acceptable acid addition salts of those compounds containing a basic nitrogen atom.

According to the invention we also provide the compounds of formula I without proviso ii) for use as 5 pharmaceuticals.

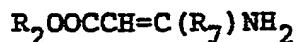
According to the invention we further provide a process for the production of a compound of formula I, or a pharmaceutically acceptable acid addition salt thereof, which comprises

10 a) reaction of a compound of formula II,



II

with compounds of formulae III and IV,



III



IV

15 in which formulae  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_7$  and  $R_8$  are as defined above,

b) reaction of a compound of formula V,

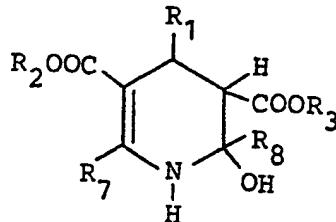


V

in which  $R_1$ ,  $R_3$  and  $R_8$  are as defined above,

20 with a compound of formula III,

c) production of a compound of formula I in which Y and Z together form a bond by dehydration of a compound of formula VII,



VII

5 in which  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_7$  and  $R_8$  are as defined above,

d) production of a compound of formula I in which  $m$  is 1 or  $p$  is 1 or 2 by selective oxidation of a corresponding compound of formula I in which  $m$  is 0, or  $p$  is 0 or 1 10 respectively,

e) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CONR}_{10}R_{11}$  by reaction of an acid halide, imidazole or a mixed anhydride of a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is 15  $-\text{COOH}$  with a compound  $\text{HNR}_{10}R_{11}$  in which  $R_{10}$  and  $R_{11}$  are as defined above, or, when the group  $-\text{NR}_{10}R_{11}$  in the product represents an imidazole, reacting the free carboxylic acid of formula I with  $\text{N,N}'\text{-carbonyldiimidazole}$ ,

f) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CSNH}_2$  by reaction of a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CN}$  20 with hydrogen sulphide,

g) isomerising a 3,4-dihydropyridine to a corresponding compound of formula I,

- h) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -C(=NH)SR<sub>9</sub> by reaction of a corresponding compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CSNH<sub>2</sub> with a compound R<sub>9</sub>-hal, in which
- 5 R<sub>9</sub> is as defined above and hal is a halogen atom,
- i) reaction of a compound of formula IV with ammonia and a compound of formula VI,



or reaction of a compound of formula V with ammonia and a  
10 compound of formula VII,



or reaction of compounds of formulae II, IV and VII  
with ammonia,

in which formulae R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>7</sub> and R<sub>8</sub> are  
15 as defined above,

j) production of a compound of formula I in which Y and Z together form a bond and one or both of R<sub>7</sub> and R<sub>8</sub> is -CHF<sub>2</sub> or -CH<sub>2</sub>F by reaction of a corresponding compound of formula I in which Y and Z together form a bond and one  
20 or both of R<sub>7</sub> and R<sub>8</sub> is -CHO or -CH<sub>2</sub>L, where L is -OH or a good leaving group, respectively with a fluorinating agent,

k) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CHO by selective hydrolysis of a  
25 corresponding compound of formula I in which one of R<sub>7</sub>

- and R<sub>8</sub> is -CH(OR<sub>9</sub>)<sub>2</sub>,
- 1) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CH<sub>2</sub>OH by selective reduction of a corresponding compound of formula I in which one of R<sub>7</sub>
- 5 and R<sub>8</sub> is -CHO,
- m) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CN by elimination of ROH from a corresponding compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CH=NOR, and -OR is a good leaving group,
- 10 n) production of a compound of formula I in which at least one of R<sub>2</sub> and R<sub>3</sub> is hydrogen by reductive cleavage or hydrolysis of a corresponding compound of formula I in which at least one of R<sub>2</sub> and R<sub>3</sub> is other than hydrogen,
- 15 o) production of a compound of formula I in which at least one of R<sub>2</sub> and R<sub>3</sub> is other than hydrogen by esterification or transesterification of a corresponding compound of formula I in which at least one of R<sub>2</sub> and R<sub>3</sub> is hydrogen or is a group R<sub>2</sub> or R<sub>3</sub> other than
- 20 that desired in the end product, or
- p) production of an optical isomer of a compound of formula I by resolution of a mixture of optical isomers of the compound,
- and where desired or necessary converting the
- 25 resulting compound of formula I to a pharmaceutically

acceptable acid addition salt thereof or vice versa.

The reaction of process a) may be carried out by subjecting the compounds of formulae II, III and IV to an elevated temperature, eg of from about 20° to 140°C in 5 the presence or absence of a suitable solvent, eg a lower alkanol.

Processes b) and i) may be carried out under similar conditions to process a). In processes a), b) and i) when y and z in the final product are together to form a bond 10 dehydration is generally required as a separate process step when R<sub>8</sub> is an electron withdrawing group, eg -CF<sub>3</sub>, perhaloalkyl-, nitro- or mono- or di-chlorophenyl or unsubstituted phenyl. The presence of a base, eg diethylamine or ammonia, tends to inhibit dehydration in 15 these processes. We prefer not to use process a), b) or i) when R<sub>7</sub> or R<sub>8</sub> is -C(=NH)SR<sub>9</sub>, -CN, -CH<sub>2</sub>OH or -CHO, or when R<sub>2</sub> or R<sub>3</sub> is hydrogen.

Process c) may be carried out in a solvent which is inert under the reaction conditions, eg methylene 20 chloride, and in the presence of a dehydrating agent, eg trifluoracetic anhydride, and a base, eg pyridine. The dehydration may also be effected using diethylaminosulphur trifluoride. The reaction may be carried out at from about 0° to 40°C. The compounds 25 of formula VII may be formed as intermediates, which may

- or may not be isolated, in processes a), b) and i). Under certain circumstances, eg when  $R_8$  is not an electron withdrawing group, the compound of formula VII may dehydrate spontaneously to yield the compound of
- 5 formula I in which Y and Z together form a bond. When diethylaminosulphur trifluoride is used in this process and  $R_8$  is  $CH_2OH$  or  $CHO$  in the starting material the  $-CH_2OH$  or  $-CHO$  will, as in process j), be converted to  $-CH_2F$  and  $-CHF_2$  respectively.
- 10 Process d) may be carried out using a suitable oxidising agent, eg peracetic acid. The reaction may be carried out in a suitable solvent, eg a mixture of methanol and acetic acid. We prefer not to use this process when  $R_7$  or  $R_8$  is  $-C(=NH)SR_9$ .
- 15 Process e) may be carried out by treating the acid halide, imidazole or the mixed anhydride (which compounds may be prepared by conventional processes known per se), with aqueous ammonia or the amine  $HNR_{10}R_{11}$  at a temperature of from  $0^\circ$  to  $30^\circ C$ . When Z is  $-OH$ , or
- 20  $R_7$  or  $R_8$  is  $-CH_2OH$ , we prefer to use the imidazole or a mixed anhydride. We prefer not to use this process when  $R_2$  or  $R_3$  is hydrogen.
- 25 Process f) may be carried out by treating the nitrile starting material with hydrogen sulphide gas in a suitable solvent, eg pyridine. The reaction is preferably carried

- out in the presence of a base, eg triethylamine, and may conveniently be carried out at a temperature of from 10 to 30°C.

Process g) may be carried out under basic conditions,  
5 eg in the presence of an alkylamine such as triethylamine. This process is particularly applicable when R<sub>8</sub> is both electron withdrawing and bulky.

Process h) may be carried out in a solvent which is inert under the reaction conditions, eg diethyl ether. We  
10 prefer hal to be iodine.

Process j) is preferably carried out at a temperature of from about -70° to 100°C, and in a solvent which is inert under the reaction conditions, e.g. a halogenated hydrocarbon and preferably methylene chloride. The  
15 fluorinating agent is preferably a dialkylaminosulphur trifluoride, e.g. diethylaminosulphur trifluoride, or (2-chloro-1,1,2-trifluoroethyl)diethylamine. The group L may be, for example, -OSO<sub>2</sub>R<sub>x</sub>, where R<sub>x</sub> is alkyl Cl to 6, e.g. methyl, or aryl, e.g. p-tolyl.

20 The hydrolysis of process k) may be carried out using an aqueous acid, for example hydrochloric acid (eg 0.5 to 2.5 molar) in a water miscible organic solvent, eg acetone or tetrahydrofuran. The reaction may be carried out at a temperature of from about -10 to 50°C.

25 The reduction of process l) may be carried out either

- chemically or catalytically, eg by use of sodium borohydride in an alcoholic solvent, eg methanol or ethanol, at a temperature of from about 0 to 50°C.

The elimination of process m) may be carried out using a variety of dehydrating agents which will not adversely effect the other substituents in the molecule, e.g., an excess of acetic anhydride, thionyl chloride in ether or N,N'-dicyclohexylcarbodiimide in pyridine. The group -OR may be, for example, a 2,4-dinitrophenoxy group. The reaction may be carried out at a temperature of from about 0° to 150°C depending on the reagent and solvent used. The oxime may, if desired, be formed in situ from the corresponding formyl compound using conventional methods known per se.

15 The reductive cleavage of process n) may be carried out chemically, eg using zinc and formic acid. The reaction may conveniently be carried out in a solvent which is inert under the reaction conditions, eg acetonitrile. When process n) involves a hydrolysis the hydrolysis may be carried out using conventional techniques known per se.

20 Process o) may, when it involves an esterification, be carried out using the appropriate alcohol, preferably in excess and in the presence of a dehydrating agent, eg dicyclohexylcarbodiimide, or under similar conditions to

- process e). The reaction may conveniently be carried out in a solvent which is inert under the reaction conditions, eg ethyl acetate. When a transesterification is involved the process may be carried out by treating the starting
- 5 ester with the sodium alcoholate corresponding to the desired ester moiety.

The resolution of process p) may be carried out by means of conversion of the mixture to, when  $R_2$  or  $R_3$  is H, a salt with an optically active base or an ester

10 with an optically active alcohol (eg  $CCl_3(C_6H_5)CHOH$  or  $C_6H_5(OCH_3)CHCH_2OH$ ), or, when  $R_2$  or  $R_3$  is aminoalkyl, a salt with an optically active acid and separation of the product by selective crystallisation, or, preferably, by means of high performance liquid

15 chromatography (HPLC). The separated product may then be converted to the desired optically active acid or ester by, for example, process n) or o).

The starting materials for the above processes are either known, or if they are not specifically known they

20 may be made by processes described in the Examples, or they may be made from known compounds using one or more process steps which are known per se or are analogous to those described in the Examples.

Certain of the compounds of formula II are novel and

25 the invention therefore also provides those compounds of

- formula II in which  $R_1$  is 2-chloro-3-trifluoromethyl phenyl or phenyl substituted by three substituents selected from chloro-, fluoro- and  $-CF_3$ . Specifically we provide 2,3-dichloro-6-fluorobenzaldehyde, 3-chloro-6-fluoro-2-(trifluoromethyl)benzaldehyde and 2-chloro-3-(trifluoromethyl)benzaldehyde.

5 The compounds of formula I and the intermediates therefor may be isolated from their reaction mixtures using conventional processes, eg crystallisation or 10 chromatography.

15 The compounds of formula I, and the pharmaceutically acceptable salts thereof, are useful because they exhibit pharmacological properties in animals. More particularly they block the entry of calcium into vascular and cardiac muscle leading to falls in blood pressure, inotropy and heart rate. They are active in the following systems:-

(a) Relaxation of contracted vascular smooth muscle. Van Breemen, Aaronson, Loutzenhiser and Meisheri, Chest, 78, Supplement, 157-165, 1980.

20 (b) Reduction of inotropy and chronotropy of isolated atria. Henry, Excerpta Med. Int. Congr. Ser., 474, 14-23, 1979.

(c) Reduction of blood pressure and increase 25 cardiac output in anaesthetised dogs. Hirakawa, Ito, Kondo, Watanbe, Hiei, Banno & Hyase, Arzneim-Forsch., 22,

• 344-349, 1972.

(d) Reduction of blood pressure in conscious dogs when given by the intravenous and oral routes. Newman, Bishop, Peterson, Leroux & Horowitz, J Pharm. Exp. Ther.

5 201, 723-730, 1977.

The compounds are thus indicated for use in the treatment of renovascular, malignant or essential hypertension (including hypertensive emergencies), pulmonary hypertension, vasospastic angina, chronic stable 10 angina and congestive heart failure. Other indications are the treatment of renal failure, cardiac arrhythmias, hypertrophic cardiomyopathy, cerebrovascular diseases (including cerebral haemorrhage, ischaemia and vasospasm, 15 migraine, altitude sickness and hearing loss), peripheral vascular diseases (including Raynauds syndrome, intermittent claudication and digital ulceration); use as a cardioplegic agent during surgery eg in cardiopulmonary bypass, and for the treatment of, and protection against, myocardial infarction and ischaemia.

20 By virtue of their ability to inhibit calcium entry into other cells and tissues the compounds are also indicated in the treatment of thrombosis, atherosclerosis, respiratory diseases (including asthma and bronchitis) glaucoma, aldosteronism, uterine hypermotility and for the 25 relief of oesophageal and skeletal muscle spasm.

For the above uses the dosage will depend upon the compound used, the route of administration and the effect desired, but in general will be in the range of 0.1-10mg per kilogram body weight per day. For man the indicated 5 total daily dose will be from about 5-500mg, preferably from 5 to 200mg and more preferably from 5 to 100mg, which may be administered preferably once daily, or in divided doses of about 1-200mg, preferably 2 to 25mg, e.g. 2 to 4 times per day.

10 The compounds of formula I are advantageous in that they possess greater potency (e.g. with respect to hypotensive and direct negative chronotropic effects), produce a lower level of reflex tachycardia, are more selective (e.g. for vascular smooth muscle vs cardiac 15 muscle), produce less depression of cardiac contractility, are longer acting, are more readily absorbed or less readily metabolised, are more easily formulated, possess less, or less undesirable, side effects, are more stable or have other more beneficial properties than known 20 compounds of similar structure.

The compounds of the invention may be administered by a wide variety of routes and may act systemically or locally. Thus the compounds may be administered by oral or nasal inhalation to the lung, to the buccal cavity, 25 oesophageally, rectally, topically to the skin, the eye or

- to other available surfaces of the body; by injection, eg intravenously, intramuscularly, intraperitoneally, or by surgical implant.

When  $R_2$  and/or  $R_3$  represents a 4, 5 or 6 membered

5 oxygen or nitrogen containing heterocyclic ring that ring may be an oxetanyl, azetidinyl, piperidinyl or tetrahydropyran ring.  $R_2$  and/or  $R_3$  may also represent  $-(CH_2)_nXR_4$ ,  $-(CH_2)_nCN$ ,  $-CH(C_6H_5)$   $CCl_3$  or  $-(CH_2)_nR_5R_6$  in which n is 4, 3 or  
10 preferably 2.

When  $R_{10}$  and  $R_{11}$  together with the nitrogen atom to which they are attached form a 5 or 6 membered heterocyclic ring we prefer that ring to be a morpholino  
15 or imidazolyl ring.

We prefer compounds of formula I in which Y and Z together form a bond. We also prefer those compounds in which one of  $R_7$  and  $R_8$  is alkyl Cl to 6, eg methyl.

We further prefer those compounds in which one of  $R_7$  and  
20  $R_8$  is mono-, di- or tri- fluoromethyl. We particularly prefer one of  $R_7$  and  $R_8$  to be mono- fluoromethyl.

Groups  $R_8$  which are electron withdrawing include alkyl Cl to 6 substituted by 2 or more halogen atoms; furanyl and phenyl optionally substituted by one or more  
25 of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro.

Preferred electron withdrawing significances of  $R_8$  are  
 $-CCl_3$ ,  $-CF_3$ ,  $-CF_2CF_3$ , phenyl, 4-nitrophenyl,  
3,4-dichlorophenyl, 4-chlorophenyl and 3-chlorophenyl.

Values for  $R_1$  include nitrophenyl;

- 5 (trifluoromethyl)phenyl; mono- or poly-fluorophenyl; mono- or poly-chlorophenyl; chloro- and/or fluoro-(trifluoromethyl)phenyl; (alkylthio)pyridyl; alkyl- and/or chloro- and/or alkoxy-nitrophenyl; mixed chloro- and fluoro-phenyl; mono- or poly- alkoxy-phenyl;
- 10 alkylphenyl; (alkylthio)phenyl; (alkylsulphonyl)phenyl; and 4-benzofurazanyl. Values for  $R_2$  and  $R_3$  are alkyl Cl to 4, 2-alkoxy Cl to 3 - ethyl, 2-phenoxy- ethyl, cycloalkyl C4 to 6 optionally substituted by methyl, the saturated 4, 5 or 6 membered heterocyclic groups as
- 15 defined immediately above and optionally substituted by phenylmethyl or diphenylmethyl, alkyl Cl to 4 - (phenylmethyl)aminoethyl, cyano- or alkyl Cl to 4 - thio-alkyl Cl to 4; phenyl alkyl Cl to 4 or  $-CH(C_6H_5)CCl_3$ . Values of  $R_8$  are chloro- or
- 20 fluoro- alkyl Cl or 2,  $-CSNH_2$ ,  $-CON(alkyl\ C\ 1\ to\ 4)_2$ ,  $-COMorpholino$ ,  $-COimidazolyl$ ,  $-C(=NH)S-alkyl\ Cl\ to\ 4$ ,  $-S-alkyl\ Cl\ to\ 4$ ,  $-S(O)-alkyl\ Cl\ to\ 4$ , or phenyl substituted by one or two chlorine, nitro, methoxy or methyl groups, e.g. in the 4- and/or 3- positions.  $R_7$
- 25 may be methyl. When  $R_7$  is not alkyl  $R_7$  and  $R_8$  are

- preferably selected from a fluoromethyl group, e.g.  $-\text{CH}_2\text{F}$ ,  $-\text{CHF}_2$  or  $-\text{CF}_3$ ;  $-\text{CHO}$ ;  $-\text{CH}(\text{OC}_2\text{H}_5)_2$ ; phenyl and  $-\text{CH}_2\text{OH}$ . The Examples illustrate various permutations of substituents. The individual substituents
- 5 exemplified may also be permuted in other combinations.

As a preferred group of compounds of formula I we provide those in which  $R_1$  is phenyl carrying a 2-nitro or a 2- $\text{CF}_3$  group or at least two substituents selected from chloro; fluoro; alkyl Cl to 6, eg methyl;  $-\text{CF}_3$  and 10 nitro;  $R_2$  is alkyl Cl to 6, eg isopropyl, cyclopentyl or cyclobutyl or is oxetan-3-yl;  $R_3$  is alkyl Cl to 6, eg methyl;  $R_7$  is alkyl Cl to 6, eg methyl;  $R_8$  is fluoromethyl, eg mono-, di- or tri-fluoromethyl; and Y and Z together form a bond.

15 As a most preferred group of compounds of formula I we provide those in which  $R_1$  is phenyl carrying at least two substituents selected from chloro, fluoro,  $-\text{CF}_3$ , methyl and nitro,  $R_3$  and  $R_7$  are both methyl,  $R_8$  is  $-\text{CH}_2\text{F}$ ,  $R_2$  is isopropyl or cyclopentyl and Y and Z 20 together form a bond.

A specific group of compounds of formula I are those in which  $R_1$  represents benzofurazanyl, pyridyl or phenyl, the pyridyl or phenyl being substituted by one or more of the groups halogen, nitro, trihalomethyl or 25  $-\text{SR}_9$ ;  $R_2$  and  $R_3$  each represent alkyl Cl to 6,

- $-(CH_2)_n R_4$ ,  $-(CH_2)_n CN$ ,  $-CH(C_6H_5)CCl_3$  or  
 $-(CH_2)_n NR_5R_6$ ; Y and Z together form a bond; one  
of  $R_7$  and  $R_8$  represents alkyl Cl to 6 and the other  
represents  $-CONR_{10}R_{11}$ ;  $-CSNH_2$ ;  $-C(=NH)SR_9$ ;
- 5  $-S(O)_m R_9$ ; phenyl substituted by one or more of alkyl  
Cl to 6, halogen, alkoxy Cl to 6 or nitro; or alkyl Cl to  
6 substituted by halogen;  $R_4$  and  $R_9$  are each alkyl Cl  
to 6; and  $R_{10}$  and  $R_{11}$  each represent hydrogen or alkyl  
Cl to 6, and provisos i) and ii) apply.
- 10 According to our invention we also provide a  
pharmaceutical composition comprising preferably less than  
80%, more preferably less than 50%, eg 1 to 20%, by weight  
of a compound of formula I, or a pharmaceutically  
acceptable salt thereof, in admixture with a  
15 pharmaceutically acceptable adjuvant, diluent or carrier.

Thus the compound may be put up as a tablet, capsule,  
dragee, suppository, suspension, solution, injection,  
implant, a topical, eg transdermal, preparation such as a  
gel, cream, ointment, aerosol or a polymer system, or an  
20 inhalation form, e.g. an aerosol or a powder formulation.

We prefer compositions which are designed to be taken  
oesophageally and to release their contents in the  
gastrointestinal tract. Thus we prefer tablets which may,  
for example, be made by direct compression. In such a  
25 process the active ingredient is mixed with one or more of

- modified forms of starch, calcium phosphate, a sugar eg lactose, microcrystalline cellulose and/or other directly compressible excipients, together with lubricant(s), eg stearic acid or magnesium stearate, flow aid(s), eg talc
- 5 or colloidal silicon dioxide, and disintegrant(s), eg starch, substituted sodium carboxymethyl cellulose, cross linked sodium carboxy methyl cellulose, carboxy methyl starch and cross linked polyvinylpyrrolidone. Tablets are then formed by direct compression, and may be sugar or
- 10 film coated e.g. with hydroxypropylmethylcellulose.

Alternatively the active ingredient may be granulated before tabletting. In such cases the active ingredient is mixed with one or more of starch, calcium phosphate, a sugar eg lactose, microcrystalline cellulose or other

- 15 suitable excipients and granulated with a binder such as starch, pregelled starch, polyvinylpyrrolidone, gelatine, a modified gelatine, or a cellulose derivative, eg hydroxypropylmethylcellulose. The mass is then dried, sieved and mixed with lubricant(s), flow aid(s) and
- 20 disintegrant(s), such as described in the previous paragraph. Tablets are then formed by compression of the granules, and may be sugar or film coated, eg with hydroxypropylmethylcellulose.

As a further alternative a powder, blend or granules,

- 25 such as are described above as intermediates in

- tabletting, may be filled into a suitable, eg gelatine, capsule.

In order to improve the bioavailability, or decrease variability of availability, of the active ingredient the 5 compound may be:-

- a) dissolved in a suitable solvent, eg polyethylene glycol, Gelucaire, arachis oil, a (hydrogenated) vegetable oil or beeswax and the solution is then filled into a gelatine capsule,
- 10 b) produced as a spray-dried or freeze-dried form prior to mixing with other excipients,
- c) milled and/or micronised to produce a powder with a large surface area prior to mixing with other excipients,
- d) made into a solution and distributed over an inert 15 excipient having a large surface area, eg colloidal silicon dioxide. The solvent is evaporated and further excipients added,
- e) formed into a complex with cyclodextrin prior to mixing with other excipients. This complex also assists 20 in increasing light stability, or
- f) made into a solid solution or co-precipitated, eg with polyvinylpyrrolidone, polyethyleneglycol, modified cellulose, hydroxypropylmethylcellulose, urea or a sugar prior to mixing with further excipients.

25 The compounds, either in their normal form or in a

- modified form, eg as described immediately above, may be formulated in a controlled release form. Thus the compound may be dispersed, or contained in, a polymer matrix formed from, for example, ethylcellulose,

5       hydroxypropylmethylcellulose or an acrylate/methacrylate polymer. Alternatively the compound may be formulated as a tablet or beads which are surrounded by a semi-permeable membrane, eg shellac, ethylcellulose or an acrylate/methacrylate polymer.

10      The compounds of this invention may be given in combination with other pharmaceutically active compounds, eg diuretics, beta-blockers, antihypertensives or inotropic agents. The dosage of the other pharmaceutically active compound can be that

15      conventionally used when the compound is administered on its own, but is preferably somewhat lower. To illustrate these combinations, a compound of this invention effective in the range, eg 5-100 milligrams per day, can be combined at levels ranging, eg from 1-200 milligrams per day with

20      the following beta-blockers, antihypertensives and diuretics in dose ranges per day as indicated:

25      hydrochlorothiazide (15-200mg), chlorothiazide (125-2000mg), ethacrynic acid (15-100mg), amiloride (5-20mg), furosemide (5-80mg), propanolol (20-480mg), timolol (5-50mg), captopril (10-500mg), methyldopa

• (65-2000mg) or digoxin (0.1-0.5mg). In addition, the triple drug combinations of hydrochlorothiazide (15-200mg) plus amiloride (5-20mg) plus a compound of this invention (3-200mg) and hydrochlorothiazide (15-200mg) plus timolol 5 (5-50mg) plus a compound of this invention (3-200mg), are provided. The above dose ranges may be adjusted on a unit basis as necessary to permit divided daily dosage. Also, the dose may vary depending on the severity of the disease, weight of patient and other factors which a 10 person skilled in the art will recognise.

Certain of the compounds of formula I are assymetric and exhibit optical isomerism. Such compounds may be separated into their optical isomers using process p) or may be made by stereospecific syntheses using conventional 15 techniques know per se.

The invention therefore provides the compounds as their individual optical isomers (we prefer the (+) isomers), and racemic or other mixtures of the individual isomers.

20 In those compounds in which Y is hydrogen and Z is -OH there will be at least 3 assymetric carbon atoms and the corresponding number of isomers is provided.

Certain of the compounds of the invention can form 25 solvates, eg hydrates or alcoholates, and certain of the compounds are light sensitive and should therefore be

- produced, handled, stored and formulated in such a manner that they are not subjected to degrading amounts of light of the appropriate wavelengths.

The invention is illustrated, but in no way limited  
5 by the following Examples in which temperatures are in  
degrees centigrade.

10

15

20

25

Example 1

3-(Methyl) 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

5 2,3-Dichlorobenzaldehyde (1.75g, 10mmoles), methyl 4-fluoro-3-oxobutanoate (1.34g, 10mmoles) and 1-methylethyl 3-amino-2-butenoate (1.43g, 10mmoles) were heated with stirring at 90° for 2.5 hours. The reaction mixture was dissolved in ethyl acetate and chromatographed 10 on silica eluting with petroleum ether (60-80°)/ethyl acetate mixtures. Pure fractions were combined and evaporated to dryness. The title compound (1.6g) was obtained by crystallisation from 2-propanol. mp 148-9°.

Example 2

15 3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-methyl-3-nitrophenyl)-3,5-pyridinedicarboxylate

2-Methyl-3-nitrobenzaldehyde (1.23g, 7.5mmoles), methyl 4-fluoro-3-oxobutanoate (1.0g, 7.5mmoles) and 20 1-methylethyl 3-amino-2-butenoate (1.07g, 7.5mmoles) were heated with stirring at 80° for 2.5 hours. The cooled residue was chromatographed twice on silica eluting first with ethyl acetate/petroleum ether (60-80°) and then with ethyl acetate/methylene chloride. The title compound 25 (0.61g) was obtained by crystallisation from a mixture of

- petroleum ether (60-80°) and 2-propanol mp 132-133°.

Example 3

5-Cyclopentyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-

5 pyridinedicarboxylate

2,3-Dichlorobenzaldehyde (1.31g, 7.5mmoles), methyl 4-fluoro-3-oxobutanoate (1.0g, 7.5mmoles) and cyclopentyl 3-amino-2-butenoate (1.26g, 7.5mmoles) were heated at 90° with stirring under nitrogen for 2.5 hours. The 10 reaction mixture was dissolved in ethyl acetate, dried (MgSO<sub>4</sub>) and the solvent was removed in vacuo. The residue was chromatographed on silica eluting with ethyl acetate/methylene chloride mixtures. The title compound (0.95g) was obtained after crystallisation from petroleum 15 ether (60-80°) mp 148-50°.

Example 4

3-Methyl 5-(1-methylethyl) 4-(3-chloro-6-fluoro-2-(trifluoromethyl)phenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

20 3-Chloro-6-fluoro-2-(trifluoromethyl)benzaldehyde (1.3g, 5.7mmoles), methyl 4-fluoro-3-oxobutanoate (0.77g, 5.7mmoles) and 1-methylethyl 3-amino-2-butenoate (0.82g, 5.7mmoles) were heated under nitrogen with stirring for 1.5 hours at 90°, followed by 1.5 hours at 100° and 25 then 1 hour at 110°. The cooled reaction mixture was

- chromatographed twice on silica first using methylene chloride as eluent and then toluene/ethyl acetate mixtures. The title compound (0.2g) was obtained after crystallisation from petroleum ether (60-80°) 5 mp 142-3°.

Example 5

3-Methyl 5-(1-methylethyl) 4-(2-chloro-3-nitrophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

10 2-Chloro-3-nitrobenzaldehyde (1.38g, 7.5mmoles), methyl 4-fluoro-3-oxobutanoate (1.0g, 7.5mmoles) and 1-methylethyl 3-amino-2-butenoate (1.06g, 7.5mmoles) were heated at 90° for 2.5 hours. The reaction mixture was chromatographed on silica eluting with petroleum ether 15 (60-80°)/ethyl acetate mixtures. The title compound (1.35g) was obtained after crystallisation from petroleum ether (60-80°)/2-propanol. mp 156-7°.

Example 6

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-4-(2-fluoro-6-(trifluoromethyl)phenyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

20 2-Fluoro-6-(trifluoromethyl)benzaldehyde (1.51g, 7.8mmoles), methyl 4-fluoro-3-oxobutanoate (1.06g, 7.8mmoles) and 1-methylethyl 3-amino-2-butenoate (1.13g, 25 7.8mmoles) were heated at 90° under nitrogen with

- stirring for 2 hours. The cooled reaction mixture was chromatographed twice; first eluting with toluene/ethyl acetate mixtures and then with ethyl acetate/petroleum ether (60-80°) mixtures. The title compound (0.1g) was obtained on evaporation of the pure fractions mp 82-4°.

Example 7

3-Methyl 5-(1-methylethyl) 4-(2,3-dichloro-6-fluorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

2,3-Dichloro-6-fluorobenzaldehyde (1.44g, 7.5mmoles), methyl 4-fluoro-3-oxobutanoate (1.0g, 7.5mmoles) and 1-methylethyl 3-amino-2-butenoate (1.06g, 7.5mmoles) were heated at 90° under nitrogen with stirring for 2.5 hours. The cooled reaction mixture was chromatographed on silica eluting with ethyl acetate/methylene chloride mixtures. The title compound (1.1g) was obtained by crystallisation from a petroleum ether (60-80°)/2-propanol mixture mp 129-31°.

The compounds of Examples 8 to 49 were prepared using appropriate starting materials and the method described in Examples 1-7.

Example 8

5-Ethyl 3-methyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

25 Recrystallised from 2-propanol. mp 127-9°.

Example 9

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

5 Recrystallized from 2-propanol/cyclohexane.

mp 107-9°.

Example 10

3-Methyl 5-(2-methylpropyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

10 Recrystallized from 2-propanol/cyclohexane.

mp 101-2°.

Example 11

3-Ethyl 5-methyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Recrystallised from 2-propanol. mp 137-8°.

Example 12

Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(trifluoromethyl)phenyl)-3,5-pyridinedicarboxylate

20 Crystallised from hexane. mp 84-6°.

Example 13

Diethyl 4-(4-benzofurazanyl)-2-(fluormethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

25 Recrystallised from methylene chloride/cyclohexane. mp 125-7°.

• Example 14

Dimethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2,3,4,5,6-pentafluorophenyl)-3,5-pyridinedicarboxylate

Crystallised from cyclohexane. mp 148-50°.

5 Example 15

5-Methyl 3-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Recrystallised from methylene chloride/cyclohexane.

10 mp 122-4°.

Example 16

5-Ethyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

15 Recrystallised from methylene chloride/cyclohexane.

mp 124-5°.

Example 17

Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(methylthio)-3-pyridyl)-3,5-pyridinedicarboxylate

20 Recrystallised from cyclohexane/petroleum ether (60-80°). mp 92-4°.

Example 18

3-Methyl 5-(2-(methyl(phenylmethyl)amino)ethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate oxalate hemihydrate

The purified free base was converted into the oxalate which was obtained as a yellow solid after trituration with ether, mp 95° with decomposition, softens at about 70°.

5 Example 19

5-(2-Methoxyethyl) 3-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Recrystallised from cyclohexane/petroleum ether (60-80°). mp 88-9°.

Example 20

5-(2-Cyanoethyl) 3-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

15 Recrystallised from 2-propanol. mp 231-232.5°.

Example 21

3-(1-Methylethyl) 5-(2-(methylthio)ethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

20 Recrystallised from 2-propanol/petroleum ether (60-80°). mp 109-111°.

Example 22

3-Methyl 5-(1-methylethyl) 4-(2-chloro-5-nitrophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Recrystallised from 2-propanol/petroleum ether (60-80°). mp. 131-133°.

Example 23

5      3-Ethyl 5-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Obtained as a solid by trituration with petroleum ether (60-80°). mp 99-101°.

Example 24

10      3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-methyl-5-nitrophenyl)-3,5-pyridinedicarboxylate

Recrystallised from 2-propanol/petroleum ether (60-80°), mp 100-1°.

15      Example 25

3-(2-Methoxyethyl) 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

20      Recrystallised from cyclohexane as yellow crystals mp 112-4°.

Example 26

5-(2-Methoxyethyl) 3-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

25      Recrystallised from cyclohexane-isopropanol as a

- yellow solid mp 95-6°.

Example 27

3-Methyl 5-(1-methylethyl) 4-(2-chloro-3-(trifluoromethyl)phenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-

5 3,5-pyridinedicarboxylate

Recrystallised from petroleum ether (60-80°)  
mp 145-7°.

Example 28

5-(1-Methylethyl) 3-(tetrahydro-4H-pyran-4-yl)  
10 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-  
-3,5-pyridinedicarboxylate

Recrystallised from petroleum ether  
(60-80°)/acetone, mp 128-30°.

Example 29

15 5-(1-Methylethyl) 3-(2-phenoxyethyl) 2-(fluoromethyl)  
-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-  
pyridinedicarboxylate

$M^+$  498; nmr (CDCl<sub>3</sub>)  $\delta$  6.6(d, NH), 5.1(s, H).

Example 30

20 5-Methyl 3-(tetrahydro-4H-pyran-4-yl) 2-(fluoromethyl)  
1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-  
pyridinedicarboxylate

Yellow prisms (acetone/petroleum ether 60-80°) mp  
152-4°.

25 Example 31

5-Cyclohexyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Orange prisms (petroleum ether 60-80°) mp 121-3°.

5 Example 32

5-Cyclopentyl 3-methyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-methyl-3-nitrophenyl)-3,5-pyridinedicarboxylate  
mp 167-8°. (2-Propanol).

Example 33

10 3-Methyl 5-(1-methylethyl) 4-(2,3-dimethoxyphenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

mp 89-91°. (Petroleum ether 60-80°/2-propanol).

Example 34

15 3-Methyl 5-(tetrahydro-4H-pyran-4-yl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Orange prisms (acetone/petroleum ether 60-80°)  
mp 143-5°.

20 Example 35

5-Cyclopentyl 3-methyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(trifluoromethyl)phenyl)-3,5-pyridinedicarboxylate

Yellow crystals (petroleum ether 40-60°)  
25 mp 122-3°.

Example 36

5-Cyclopentyl 3-methyl 4-(3-chloro-6-fluoro-2-(trifluoromethyl)phenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

5 mp 184-6°. (2-Propanol/petroleum ether 60-80°).

Example 37

5-(1-Ethylpropyl) 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

10 Pale yellow prisms (petroleum ether 40-60°)  
mp 118-9°.

Example 38

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-4-(2-methoxy-3-nitrophenyl)-6-methyl-3,5-

15 pyridinedicarboxylate

mp 105-6°. (2-Propanol/petroleum ether 60-80°).

Example 39

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(trifluoromethyl)phenyl)-3,5-

20 pyridinedicarboxylate

Pale yellow crystals (hexane) mp 71-2°.

Example 40

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-nitrophenyl)-3,5-

25 pyridinedicarboxylate

Yellow crystals (petroleum ether 60-80°)  
mp 142-3°.

Example 41

5 3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-4-(2-fluorophenyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Yellow crystals (petroleum ether 60-80°)  
mp 129-31°.

Example 42

10 3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-methylphenyl)-3,5-pyridinedicarboxylate

Pale yellow crystals (petroleum ether 60-80°)  
mp 94-5°.

15 Example 43

3-Methyl 5-(1-methylethyl) 4-(2-chlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinecarboxylate

Yellow crystals (petroleum ether 60-80°)  
mp 137-9°.

Example 44

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(methylthio)phenyl)-3,5-pyridinedicarboxylate

25 Example 45

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(methylsulphonyl)phenyl)-3,5-pyridinedicarboxylate

Example 46

5       3-Methyl 5-(1-methylethyl) 4-(3-chloro-2-methylphenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

mp 73-5° (cyclohexane).

Example 47

10      3-Methyl 5-(1-methylethyl) 4-(2,3-dimethylphenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Example 48

15      3-Methyl 5-(1-methylethyl) 4-(3-cyanophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Pale yellow crystals (2-propanol/petroleum ether 60-80°) mp 117-8°.

Example 49

20      3-Methyl 5-(1-methylethyl) 4-(3-chlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Pale yellow crystals (petroleum ether 60-80°) mp 107-9°.

25 Example 50

• Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(trifluoromethyl)-3,5-pyridinedicarboxylate

3-Nitrobenzaldehyde (3.0g, 20 mmoles), ethyl 5 3-amino-2-butenoate (2.6g, 20 mmoles) and ethyl 4,4,4-trifluoro-3-oxobutanoate (2.92ml, 20 mmoles) were heated at reflux in ethanol (25ml) for 6 hours. The solvent was removed in vacuo and the residue crystallised by the addition of ether/petroleum ether (60-80°). The 10 resulting solid was recrystallised from ether/petroleum ether (60-80°) to give the title compound as colourless crystals (1.9g) mp 120-1°.

Example 51

15 3-Ethyl 5-methyl 4-(2,3-dichlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-2-(trifluoromethyl)-3,5-pyridinedicarboxylate

Prepared by the method of Example 50. Two isomeric compounds were obtained. Isomer 1 recrystallised from cyclohexane mp 140-1°. Isomer 2 recrystallised from 20 cyclohexane mp 118-9.5°.

Example 52

Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(pentafluoroethyl)-3,5-pyridinedicarboxylate

25 Prepared by the method of Example 50. Two isomeric

- compounds were obtained. Isomer 1 recrystallised from 2-propanol mp 103-4°. Isomer 2 recrystallised from 2-propanol mp 121-2°.

Example 53

5 5-Cyclopentyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

a) Cyclopentyl 2-(2,3-dichlorophenylmethylen)-3-oxobutanoate

10 A solution of 2,3-dichlorobenzaldehyde (2.5g, 14.3mmoles), cyclopentyl 3-oxobutanoate (2.42g, 14.3mmoles), piperidine (8 drops) and hexanoic acid (11 drops) in dry benzene (80ml) was heated at reflux for 4 hours using a Dean and Stark apparatus. The solution was 15 allowed to cool to room temperature and the solvent removed in vacuo to leave the sub-title compound as an oil 5.1g.

b) A solution of the product of step a) (5.1g, 14.3mmoles) and methyl 3-amino-4-fluoro-2-butenoate (1.9g,

20 14.3mmoles) in dry tert-butanol (25ml) was heated to 60° (oil bath temperature) for 108 hours. The solution was allowed to cool to room temperature and the solvent removed in vacuo. Chromatography on silica eluting with dichloromethane afforded the title compound as a yellow 25 oil which crystallises on addition of petroleum ether

- (60-80°) to afford the title compound 1.5g mp 148-9°.  
(Identical with the product of Example 3).

Example 54

5-Cyclobutyl 3-methyl 4-(2,3-dichlorophenyl)-2-  
5 (fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate

a) Cyclobutyl 2-(2,3-dichlorophenylmethylene)-3-  
oxobutanoate

A solution of 2,3-dichlorobenzaldehyde (1.57g, 8.9mmoles), cyclobutyl 3-oxobutanoate (1.4g, 8.9mmoles), piperidine (8 drops) and hexanoic acid (11 drops) in dry benzene (100ml) was heated at reflux for 12 hours using a Dean and Stark apparatus. The solution was allowed to cool to room temperature and the solvent removed in vacuo to leave the crude sub-title compound as an oil 3.5g.

Chromatography on silica eluting with petroleum ether (60-80°)/ethyl acetate mixtures afforded the sub-title compound as an oil, 1.7g.

b) The product of step a) (1.7g, 5.4mmoles) and methyl 3-amino-4-fluoro-2-butenoate (0.72g, 5.4mmoles) were mixed and heated to 95° (oil bath temperature) under an atmosphere of nitrogen for 6 hours. The oil was allowed to cool to room temperature. Chromatography on silica eluting with petroleum ether (60-80°)/ethyl acetate mixtures, afforded the title compound as a yellow solid,

which was recrystallised from petroleum ether (60-80°) to afford the title compound 0.37g, mp 148-9°.

Example 55

5 3-Methyl 5-(3-oxetanyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

a) (3-Oxetanyl) 2-(2,3-dichlorophenylmethylen)-3-oxobutanoate

A solution of 2,3-dichlorobenzaldehyde (1.33g, 7.6mmoles), 3-oxetanyl 3-oxobutanoate (1.2g, 7.6mmoles), piperidine (6 drops) and hexanoic acid (8 drops) in dry benzene (80ml) was heated at reflux using a Dean and Stark apparatus. The solution was allowed to cool to room temperature and the solvent removed in vacuo to leave the 15 sub-title compound as an oil 2.9g.

b) A solution of the product of step a) (2.9g, 7.6mmoles) and methyl 3-amino-4-fluoro-2-butenoate (1g, 7.6mmoles) in dry tert-butanol (20ml) was heated to 60° (oil bath temperature) for 16 hours. The solution was 20 allowed to cool to room temperature and the solvent removed in vacuo. Chromatography on silica, eluting with dichloromethane/ethyl acetate mixtures afforded the title compound as an oil which crystallised on addition of petroleum ether (60-80°). The solid was recrystallised 25 from petroleum ether (60-80°)/acetone to afford the

title compound 1.03g, mp 155-6°.

Example 56

Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(trichloromethyl)-3,5-

5 pyridinedicarboxylate

a) Ethyl 4,4,4-trichloro-2-(3-nitrophenylmethylene)-3-oxobutanoate

3-Nitrobenzaldehyde (7.55g, 50mmoles), ethyl 4,4,4-trichloro-3-oxobutanoate (18.33g, 59.5mmoles), piperidine (0.66ml) and hexanoic acid (0.33ml) were heated at reflux in toluene (130ml) for 48 hours using a Dean and Stark apparatus. The mixture was cooled, evaporated to dryness in vacuo and crystallised by trituration with ethyl acetate/petroleum ether (60-80°). Recrystallisation from 2-propanol gave the sub-title compound (5.3g) mp 105.5-7°.

b) Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(trichloromethyl)-3,5-pyridinedicarboxylate

20 Ethyl 4,4,4-trichloro-2-(3-nitrophenylmethylene)-3-oxobutanoate (7.19g, 0.02mmoles) and ethyl 3-amino-2-butenoate (2.53g) were heated at 60° for 24 hours in tert-butanol (60ml). The solvent was evaporated and the residue chromatographed on silica eluting with ether/petroleum ether (60-80°) mixtures to give the

title compound (4.04g). Recrystallised from 2-propanol.  
mp 125-6.5°.

Example 57

3-Methyl 5-((S)-2,2,2-trichloro-1-phenylethyl) 4-(2,3-  
5 dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate

a) (S)-2,2,2-Trichloro-1-phenylethyl 2-(2,3-  
dichlorophenylmethylene)-3-oxobutanoate  
(S)-2,2,2-Trichloro-1-phenylethyl 3-oxobutanoate

10 (8.6g, 27.5mmoles) and 2,3-dichlorobenzaldehyde (4.82g,  
27.5mmoles) in dry benzene (100ml) were heated at reflux  
for 5 hours with hexanoic acid (25 drops) and piperidine  
(8 drops) in a Dean and Stark apparatus. The solvent was  
evaporated and the residue dissolved in ethyl acetate

15 (200ml), washed with saturated sodium bicarbonate, 2%  
aqueous sodium bisulphite solution and brine, dried  
(MgSO<sub>4</sub>) and the solvent removed in vacuo. The sub-title  
compound was obtained as a yellow oil. HPLC and nmr  
indicate 2:1 mixture of geometric isomers.

20 b) 3-Methyl 5-((S)-2,2,2-trichloro-1-phenylethyl) 4-(2,3-  
dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate Single diastereomers A and B  
(S)-2,2,2-Trichloro-1-phenylethyl 2-(2,3-  
dichlorophenylmethylene)-3-oxobutanoate (10.8g, 23mmoles)

25 and methyl 3-amino-4-fluoro-2-butenoate (3.7g, 28mmoles)

- were heated at 55° in dry tert- butanol (50ml) for 68 hours. The solvent was removed and the residue purified and separated into single diastereomers by HPLC eluting with methylene chloride/petroleum ether (60-80°) mixtures.

First eluted: diastereomer A, recrystallised from cyclohexane/petroleum ether (60-80°) mp 167.5-8°  $[\alpha]_D^{25} +17.5^\circ$  (c, 0.1 in ethanol).

Second eluted: diastereomer B, recrystallised from 10 petroleum ether (60-80°) mp 141-3°  $[\alpha]_D^{25} -150.1^\circ$  (c, 0.1 in ethanol).

Example 58

3-Methyl 5-(2,2,2-trichloro-1-phenylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-15 pyridinedicarboxylate Diastereomeric pairs A and B

Prepared by the method of Example 57 and separated by HPLC using methylene chloride/petroleum ether (60-80°) mixtures.

First eluted: diastereomeric pair A. Recrystallised 20 from cyclohexane/petroleum ether (60-80°) mp 203-4°.

Second eluted: diastereomeric pair B.

Recrystallised from cyclohexane/petroleum ether (60-80°) mp 176-176.5°.

The compounds of Examples 59 to 73 were prepared 25 using appropriate starting materials and the method

described in Examples 53-58.

Example 59

Diethyl 2-(difluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

5 mp 148°-9° (2-propanol).

Example 60

Diethyl 1,4-dihydro-2-methyl-6-methylthio-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

mp 123-5° (2-propanol).

10 Example 61

Diethyl 1,4-dihydro-2-(4-methoxyphenyl)-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

mp 166-7° (2-Propanol).

Example 62

15 Diethyl 2-(dichloromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Recrystallised from isopropanol as yellow crystals  
mp 139-141°.

Example 63

20 Diethyl 1,4-dihydro-2-methyl-6-phenyl-4-(2-(trifluoromethyl)phenyl)-3,5-pyridinedicarboxylate

Recrystallisation from 2-propanol gave the title compound (3.7g) mp 149-150°.

Example 64

25 5-Methyl 3-(1-methylethyl) 4-(4-benzofurazanyl)-1,4-

• dihydro-2-methyl-6-phenyl-3,5-pyridinedicarboxylate

Recrystallised from 2-propanol to give the title compound mp 198-200°.

Example 65

5 5-Methyl 3-(1-methylethyl) 1,4-dihydro-2-methyl-6-phenyl-4-(2-(trifluoromethyl)phenyl)-3,5-pyridinedicarboxylate

Recrystallised from petroleum ether (60-80°) mp 111-2°.

10 Example 66

5-Ethyl 3-methyl 4-(2,3-dichlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-2-phenyl-3,5-pyridinedicarboxylate

The title compound was obtained as a white solid.

15 Nmr ( $D_6$ -DMSO)  $\delta$  6.0 (s, 1H), 4.9 (d, 1H, J=11Hz), 0.7 (t, 3H, J=7Hz).

Example 67

Diethyl 4-(4-benzofurazanyl)-2-diethoxymethyl-1,4,5,6-tetrahydro-6-hydroxy-6-(trifluoromethyl)-3,5-pyridinedicarboxylate

20

The title product was obtained as an oil.  $M^+$  531.

Example 68

25

5-(1-(Diphenylmethyl)-3-azetidinyl) 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

• Pale yellow solid (petroleum ether 60-80°)  
mp 163-5°.

Example 69

5 3-Methyl 5-(1-(phenylmethyl)-4-piperidinyl)  
4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-  
methyl-3,5-pyridinedicarboxylate  
Pale yellow solid. mp 118-20°.

Example 70

10 5-(1,1-Dimethylethyl) 3-methyl 4-(2,3-dichlorophenyl)  
-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate  
Pale yellow solid (petroleum ether 60-80°)  
mp 141°.

Example 71

15 3-Methyl 5-(1-methyl-1-phenylethyl) 4-(2,3-  
dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate  
Colourless solid (acetone-petroleum ether 60-80°).

mp 173-5°.

20 Example 72

3-Methyl 5-(1-methylcyclopentyl) 4-(2,3-  
dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate

Colourless solid (petroleum ether 60-80°).  
25 mp 111°.

Example 73

3-Methyl 5-(2,2,2-trichloro-1-phenylethyl)  
2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)  
-3,5-pyridinedicarboxylate

5 Diastereomers obtained as yellow foam.

$M^+$  562/560/558/556. Nmr ( $CDCl_3$ )  $\delta$  5.24 and 5.26 (2xs,1H), 6.32 and 6.34 (2xs,1H).

Example 74

Diethyl 2-(fluoromethyl)-6-formyl-1,4-dihydro-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

10 Ethyl 4,4-diethoxy-2-(3-nitrophenylmethylen)-3-oxobutanoate (21.75g, 62mmoles) and ethyl 3-amino-4-fluoro-2-butenoate (9.17g, 68mmoles) were heated at  $125^\circ$  for 1.5 hours. The reaction mixture was

15 dissolved in ethyl acetate (150ml), washed with water and saturated brine, dried ( $MgSO_4$ ) and the solvent was removed in vacuo. The residue was dissolved in tetrahydrofuran (195ml) and 50% aqueous hydrochloric acid (292ml) was added slowly. After 30 minutes the reaction

20 mixture was extracted with ethyl acetate and the organic extract washed with saturated aqueous sodium bicarbonate, water, dried ( $MgSO_4$ ) and the solvent was removed in vacuo. The residue was chromatographed on silica eluting with ethyl acetate/petroleum ether ( $60-80^\circ$ ) mixtures.

25 Crystallisation from 2-propanol gave the title compound

- (4.6g), mp 88-90°.

Example 75

3-Methyl 5-(1-methylethyl) 4-(4-benzofurazanyl)-  
1,2,3,4-tetrahydro-2-hydroxy-6-methyl-2-phenyl-3,5-  
5 pyridinedicarboxylate

4-Benzofurazancarboxaldehyde (2.96g, 20mmoles), methyl beta-oxobenzene propanoate (3.56g, 20mmoles), piperidine (0.05ml) and hexanoic acid (0.13ml) were heated at reflux for 3 hours in benzene (50ml) using a Dean and Stark apparatus. The reaction was cooled, diluted with ethyl acetate and washed in turn with water, brine and saturated sodium bicarbonate and dried ( $\text{Na}_2\text{SO}_4$ ). The solvent was removed in vacuo and the residue dissolved in ethanol (6ml). 1-Methylethyl 3-amino-2-butenoate (3.0g) and diethylamine (0.6ml) were added and the mixture heated at 60° for 34 hours. The reaction mixture was cooled, evaporated to dryness in vacuo and the residue was dissolved in 2-propanol and treated with charcoal. The charcoal was filtered off and the title compound (1.1g) was obtained on addition of cyclohexane mp 132-4°.

Example 76

Diethyl 2-amino-6-(fluoromethyl)-1,4-dihydro-4-  
(3-nitrophenyl)-3,5-pyridinedicarboxylate

Ethyl 4-fluoro-2-(3-nitrophenylmethylene)-3-  
25 oxobutanoate (0.6g, 2.1mmoles) and ethyl 3,3-diamino-2-

propenoate hydrochloride (0.34g, 12.0mmoles) were heated at reflux in ethanol (10ml) and a solution of sodium (0.05g) in ethanol (5ml) was added over one hour. The resulting solution was heated at reflux for a further 10 5 minutes and then filtered hot. The ethanolic solution was evaporated to dryness in vacuo and the resulting solid triturated with 2-propanol. The resulting solid was chromatographed on silica eluting with ether/petroleum ether (60-80°) mixtures to give pure title compound, mp 10 177-8°.

Example 77

Diethyl 2-(fluoromethyl)-1,4,5,6-tetrahydro-6-hydroxy-4-(3-nitrophenyl)-6-phenyl-3,5-pyridinedicarboxylate and  
Diethyl 2-(fluoromethyl)-1,4-dihydro-4-  
15 (3-nitrophenyl)-6-phenyl-3,5-pyridinedicarboxylate  
Ethyl alpha-(3-nitrophenylmethylene)-beta-oxobenzenepropanoate (1.66g, 16.3mmoles), ethyl 3-amino-4-fluoro-2-butenoate (0.75g, 15.6mmoles) and piperidine (0.06ml) were heated at 60° in ethanol (1ml) 20 for 72 hours. The reaction mixture was cooled and diluted with ethanol. The solid was filtered off, dried and then chromatographed on silica eluting with ethyl acetate/petroleum ether (60-80°) mixtures to give the hydroxy compound (0.43g) mp 188-90°(dec).  
25 The ethanolic mother liquors were evaporated to

- dryness in vacuo, dissolved in methylene chloride and pyridine (0.58ml), and trifluoroacetic anhydride (0.48ml) was added with stirring. After 16 hours, the solution was washed with 5% aqueous acetic acid (3 x 10ml), and

5 saturated sodium bicarbonate, dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent was removed in vacuo. The residue was chromatographed on silica eluting with ethyl acetate/petroleum ether (60-80°) mixtures.

10 Recrystallisation from 2-propanol gave the dihydropyridine (0.31g), mp 151-2°.

Example 78

3-Ethyl 5-methyl 4-(2,3-dichlorophenyl)-1,4-dihydro-2-methyl-6-phenyl-3,5-pyridinedicarboxylate

15 Ammonia (0.5ml, d = 0.88) was added to a solution of methyl alpha-(2,3-dichlorophenylmethylene)-beta-oxobenzenepropanoate (2g, 7.3mmoles) and ethyl 3-amino-2-butenoate (0.77g, 6.0mmoles) in tert. butanol (8ml) at 60°. The reaction was maintained at this temperature for 16 hours. The solvent was removed in

20 vacuo and the residue was chromatographed on silica eluting with ethyl acetate/petroleum ether (60-80°) mixtures. The title compound (0.25g) was obtained after crystallisation from 2-propanol mp 185-6°.

Example 79

25 Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-

• (4-nitrophenyl)-3,5-pyridinedicarboxylate

Trifluoroacetic anhydride (0.65ml, 4.63mmoles) was added with stirring to pyridine (0.75ml, 9.26mmoles) and diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(4-nitrophenyl)-3,5-pyridinedicarboxylate (2.31g, 4.63mmoles) in methylene chloride (60ml). After stirring for 2.5 hours, the solution was washed with water, dilute hydrochloric acid (x3), water, saturated sodium bicarbonate solution, water and dried 10 (Na<sub>2</sub>SO<sub>4</sub>). The solvent was removed in vacuo and the residue recrystallised from ethanol to give the title compound (1.77g) as a yellow solid, mp 176-7°.

The compounds of Examples 80 to 86 were prepared using appropriate starting materials and the method of 15 Example 79.

Example 80

Diethyl 2-(3,4-dichlorophenyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate  
Yellow solid mp 153-6° (ethanol).

20 Example 81

Diethyl 2-(4-chlorophenyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate  
Yellow solid mp 158-60° (ethanol).

Example 82

25 Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-

• (trifluoromethyl)-3,5-pyridinedicarboxylate

Yellow solid mp 93-5° (ether-petroleum ether 60-80°).

Example 83

5 Diethyl 2-(3-chlorophenyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Recrystallised from 2-propanol. mp 160-1°.

Example 84

10 Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-(pentafluoroethyl)-3,5-pyridinedicarboxylate

Obtained pure after chromatography. mp 88-9°.

Example 85

15 5-Ethyl 3-methyl 4-(2,3-dichlorophenyl)-1,4-dihydro-2-methyl-6-(trifluoromethyl)-3,5-pyridinedicarboxylate

Recrystallised from cyclohexane, mp 101-2°.

Example 86

20 Diethyl 4-(4-benzofurazanyl)-2-(diethoxymethyl)-1,4-dihydro-6-(trifluoromethyl)-3,5-pyridinedicarboxylate

Obtained as an oil. Nmr ( $CDCl_3$ )  $\delta$  6.1(s,H), 5.6(s,H).

Example 87

25 Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-(trichloromethyl)-3,5-pyridinedicarboxylate

a) Diethyl 3,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-

(trichloromethyl)-3,5-pyridinedicarboxylate

Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(trichloromethyl)-3,5-pyridinedicarboxylate (3.0g, 6.05mmoles) was dissolved in dry methylene chloride (150ml) and diethylaminosulphur trifluoride (1.5ml) was added. After 1 hour the solution was diluted with methylene chloride and washed in turn with dilute hydrochloric acid and saturated sodium bicarbonate solution. After drying ( $MgSO_4$ ), the solvent was removed in vacuo to give the sub-title compound (2.82g) as an oil. Nmr ( $D_6$ -DMSO)  $\delta$  4.8 (s, H), 4.4 (s, H).

b) Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-(trichloromethyl)-3,5-pyridinedicarboxylate

The product of step a) (2.67g) was dissolved in methylene chloride (20ml) and triethylamine (0.5ml) was added. After 18 days at room temperature, the solvent was evaporated and the residue chromatographed on silica eluting with methylene chloride. The title compound (0.65g) was obtained after crystallisation from 2-propanol mp 113-5°. Nmr ( $D_6$ -DMSO)  $\delta$  9.0 (s, H), 4.9 (s, H).

Example 88

Diethyl 1,4-dihydro-2-methyl-6-(methylsulphinyl)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate Isomers I and II

Peracetic acid (6.8ml of 1M solution in methanol) was added to a solution of diethyl 1,4-dihydro-2-methyl-6-

(methylthio)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate (2.77g 6.8mmoles) in methylene chloride (150ml) at -78°. The reaction mixture was allowed to reach room temperature and was then stirred for 30 minutes.

- 5 Saturated aqueous sodium bicarbonate (150ml) was added and the organic layer separated, dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent removed in vacuo. The residue was chromatographed on silica, eluting with ether/petroleum ether (60-80°) mixtures. The two isomers were separated and
- 10 recrystallised from 2-propanol.

Diastereomer I yellow crystals mp 143-4° (0.84g).

Diastereomer II yellow crystals mp 133-5° (1.25g).

#### Example 89

- 15 Diethyl 2-aminocarbonyl-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

A solution of 3,5-diethyl 1,4-dihydro-6-methyl-4-(3-nitrophenyl)-2,3,5-pyridinetricarboxylate (4.0g; 10.3mmoles), 1,1'-carbonyldiimidazole (1.75g; 10.8mmoles) in dry dichloromethane (180ml) was stirred at room temperature under an atmosphere of dry nitrogen. After 2 hours a yellow suspension had formed, ammonia solution (20ml, d=0.88) was added and the 2-phase mixture left stirring for 16 hours.

Saturated brine (100ml) was added, the organic

- 25 solution was separated, washed with 15% aq. sodium

- hydroxide solution, saturated brine, water and dried ( $MgSO_4$ ).

Evaporation of the solvent was followed by chromatography on silica (150g) using ethyl acetate/petroleum ether (60-80°) as eluent.

The title compound was obtained as a white solid which was recrystallised from 2-propanol to give a white powder (0.8g) mp 166-8°.

Example 90

10 Diethyl 2-(dimethylaminocarbonyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Thionyl chloride (0.05ml) was added to a solution of 3,5-diethyl 1,4-dihydro-6-methyl-4-(3-nitrophenyl)-2,3,5-pyridinetricarboxylate (0.25g, 0.62mmoles) in methylene chloride (10ml) containing dimethylformamide (1 drop).

After 2 hours at room temperature further thionyl chloride (0.05ml) was added and the solution was refluxed for 30 mins. After cooling to room temperature 10% dimethylamine in benzene (1 ml) was added and the mixture stirred for 30 mins. The solvent was evaporated and the residue dissolved in dilute hydrochloric acid and ether. The organic extract was washed with brine, dried ( $Na_2SO_4$ ) and the solvent removed in vacuo to leave the title compound (0.2g).  $M^+$  431; nmr ( $CDCl_3$ )  $\delta$  5.12 (s, H), 3.05 (s, 3H), 2.95 (s, 3H).

Example 91

Diethyl 1,4-dihydro-2-(1H-imidazol-1-ylcarbonyl)-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate and  
Diethyl 1,4-dihydro-2-methyl-6-(4-morpholinylcarbonyl)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

5      Diethyl 1,4-dihydro-2-methyl-6-(4-morpholinylcarbonyl)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

A solution of 3,5-diethyl 1,4-dihydro-6-methyl-4-(3-nitrophenyl)-2,3,5-pyridinetricarboxylate (2.5g, 6.2mmoles) and 1,1'-carbonyldiimidazole (1.2g, 7.4mmoles) in methylene chloride (100ml) was stirred at room 10 temperature for 4 hours. Morpholine (1.08ml, 12.4mmoles) was added, the mixture stirred overnight and then poured onto 10% hydrochloric acid. The organic layer was separated, washed with 10% hydrochloric acid, brine, saturated sodium bicarbonate, brine and dried 15  $(\text{Na}_2\text{SO}_4)$ . The solvent was evaporated and the residue chromatographed on silica eluting with ethyl acetate/petroleum ether (60-80°) mixtures. The imidazolyl-carbonyl (0.24g) compound was eluted first ( $M^+ 454$ ).

20      Further elution afforded the morpholinylcarbonyl compound (0.4g) ( $M^+ 473$ ).

Example 92

Diethyl 2-(aminothioxomethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

25      Hydrogen sulphide was bubbled through a solution of

diethyl 2-cyano-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate (1g, 2.6mmoles) in triethylamine (0.36ml, 2.6mmoles) and pyridine (20ml) at room temperature for 2 hours. The solution was degassed with 5 nitrogen and poured into water (300ml). After stirring for 2 hours, the precipitate was filtered off, dissolved in methylene chloride and dried ( $\text{Na}_2\text{SO}_4$ ). The solvent was removed in vacuo and the residue triturated with  $\text{CCl}_4$  and filtered to give the title compound 10 (0.5g).  $\text{M}^+ 419$ ; ( $\text{CDCl}_3$ )  $\delta$  9.3 (s,  $\text{NH}_2$ ), 5.2 (s, H).

Example 93

Diethyl 1,4-dihydro-2-(imino(methylthio)methyl)-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate hydroiodide

15. Methyl iodide (0.06ml, 0.96mmoles) was added to a solution of diethyl 2-(aminothioxomethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate (0.2g, 0.48mmoles) in methanol (10ml). After stirring for 16 hours at room temperature methyl iodide (0.1ml) was 20 added and the stirring continued for 1 day. The solvent was evaporated and the residue crystallised on addition of ether. The hydroscopic solid was filtered and dried in vacuo to give the title compound (0.17g).

Nmr ( $\text{CDCl}_3$ )  $\delta$  5.9 (s, H), 2.9 (s, SMe).

25 Example 94

• Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Ethyl 4-fluoro-3-oxobutanoate (1.45g, 10mmoles), ethyl 2-(3-nitrophenylmethylene)-3-oxobutanoate (2.63g, 5 10mmoles) and aqueous ammonia (1.1ml, d 0.88) were heated at reflux in ethanol (15ml) for 6 hours. The solvent was removed in vacuo and the residue purified by chromatography on silica eluting with petroleum ether (60-80°)/ether mixtures. Recrystallisation from 10 ether/petroleum ether (60-80°) gave the title compound (1.1g) as yellow crystals mp 139-41°.

The compounds of Examples 95 to 104 were prepared using appropriate starting materials and the method of Example 94.

15 Example 95

Di-(2-propoxyethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Recrystallised from ether-hexane as a yellow solid mp 52-3°.

20 Example 96

Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(4-nitrophenyl)-3,5-pyridinedicarboxylate

Recrystallised from ethanol as yellow needles mp 196-7°.

25 Example 97

5-Methyl 3-(1-methylethyl) 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-phenyl-3,5-pyridinedicarboxylate  
mp 184.5-185.5° (2-propanol).

Example 98

5 Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-phenyl-3,5-pyridinedicarboxylate  
m.p. 213-5°. (Ethanol).

Example 99

10 Diethyl 2-(3,4-dichlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

White solid mp 188-9°. (Ethanol).

Example 100

15 Diethyl 2-(4-chlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Yellow solid mp 175-8°. (Ethanol).

Example 101

20 Diethyl 1,4-dihydro-2-methyl-6-(4-methylphenyl)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate  
mp 149-50°. (Ethanol).

Example 102

25 3-Methyl 5-(1-methylethyl) 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-phenyl-3,5-pyridinedicarboxylate

mp 134-5°. (2-Propanol).

Example 103

Diethyl 2-(3-chlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-3,5-

5 pyridinedicarboxylate

mp 212-4°. (Ethanol).

Example 104

Diethyl 2-(2-furanyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

10 mp 130-1° (2-propanol).

Example 105

3-Methyl 5-(1-methylethyl) 2-(difluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Diethylaminosulphur trifluoride (0.64ml, 5.1mmoles)

15 was added to a stirred solution at -10° of 3-methyl 5-(1-methylethyl) 2-formyl-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate (2g, 5.2mmoles) in dry methylene chloride (20ml). After stirring for 2 hours at -10° and 1 hr at room temperature,

20 diethylaminosulphur trifluoride (0.2ml) was added and the stirring continued for a further hour. The reaction mixture was poured into aqueous sodium bicarbonate (100ml) and extracted with methylene chloride (2 x 100ml). The organic extracts were washed with water (2x) and brine,

25 dried ( $MgSO_4$ ) and the solvent was evaporated.

- Chromatography on silica eluting with ethyl acetate/petroleum ether (60-80°) mixtures, followed by crystallisation from 2-propanol gave the title compound (0.57g). mp 140-1°.

5 Example 106

5-Cyclopentyl 3-methyl 2-(difluoromethyl)-1,4-dihydro-6-methyl-4-(2-methyl-3-nitrophenyl)-3,5-pyridinedicarboxylate

5-Cyclopentyl 3-methyl 2-formyl-1,4-dihydro-6-methyl-4-(2-methyl-3-nitrophenyl)-3,5-pyridinedicarboxylate (0.62g, 1.45mmoles) was dissolved in dry methylene chloride (6ml) and then cooled to 0°. Diethylaminosulphur trifluoride (180 $\mu$ l, 1.45mmoles) was added and the reaction mixture stirred at room temperature for 4 hours. The solvent was removed in vacuo and the residue chromatographed on silica eluting with ether/petroleum ether (60-80°) mixtures. The title compound (0.22g) was obtained on evaporation of pure fractions mp 154-6°.

20 Example 107

3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(difluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-formyl-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

• (1.5g, 3.6mmoles) was dissolved in dry methylene chloride (20ml) and cooled to -60°. Diethylaminosulphur trifluoride (0.59g, 3.6mmoles) was added and the stirred mixture was allowed to reach room temperature. After 2  
5 hours, the solvent was removed in vacuo and the residue chromatographed on silica eluting with methylene chloride/ethyl acetate mixtures. The title compound (0.6g) was obtained, after crystallisation from 2-propanol. mp 156-7°.

10 Example 108

Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

Diethyl 1,4-dihydro-2-(hydroxymethyl)-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate (0.1g,  
15 0.25mmoles) in dry methylene chloride (5ml) was added to a stirred solution at -60° of diethylaminosulphur trifluoride (0.068ml, 0.55mmoles) in dry methylene chloride (10ml) over 10 minutes. The reaction mixture was allowed to reach room temperature over 2.5 hours,  
20 poured into aqueous sodium bicarbonate (15ml) and the aqueous layer extracted with methylene chloride (2x). The organic extracts were washed with water, dried ( $MgSO_4$ ) and the solvent was evaporated. The residue was chromatographed on silica eluting with ethyl acetate/methylene chloride mixtures to give the title  
25

- compound (0.015g); identical with that prepared in Example 94.

The compounds of Examples 109 and 110 were prepared using appropriate starting materials and the method 5 described in Examples 105-107.

Example 109

3-(2-Methoxyethyl) 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(difluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

10 mp. 127-128°. (2-Propanol).

Example 110

3-(2-Methoxyethyl) 5-(1-methylethyl) 2-(difluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

15 mp 146-7°. (2-Propanol).

Example 111

Diethyl 4-(4-benzofurazanyl)-2-formyl-1,4-dihydro-6-(trifluoromethyl)-3,5-pyridinedicarboxylate

To a solution of diethyl 4-(4-benzofurazanyl)-2-(diethoxymethyl)-1,4-dihydro-6-(trifluoromethyl)-3,5-pyridinedicarboxylate (7.6g, 14.5mmoles) in tetrahydrofuran (100ml) was added 25% aqueous hydrochloric acid solution (100ml) and the resulting solution heated at reflux. After 1.5 hours the cooled solution was poured 25 into ethyl acetate (200ml). The organic phase was

separated and washed with water, saturated aqueous sodium bicarbonate solution, brine and dried ( $MgSO_4$ ).  
Evaporation of the solvent left an oil (7.5g) which was purified by chromatography on silica (300g) using 5 ether-petroleum ether (60-80°) as eluent. The major component was obtained as an oil which gave a solid on trituration with 2-propanol. Recrystallisation from 2-propanol gave the title compound (0.45g) as yellow crystals mp 94-5°.

10 Example 112

Diethyl 4-(4-benzofurazanyl)-1,4-dihydro-2-(hydroxymethyl)-6-trifluoromethyl-3,5-pyridinedicarboxylate

A solution of diethyl 4-(4-benzofurazanyl)-2-formyl-1,4-dihydro-6-(trifluoromethyl)-3,5-pyridinedicarboxylate 15 (1.1g; 2.5mmoles) in dry ethanol (90ml) was cooled to 0° and sodium borohydride (0.14g; 3.7mmoles) was added portionwise over 3 minutes. After 10 minutes, 10% aqueous hydrochloric acid was added dropwise to pH3, and the mixture concentrated in vacuo at room temperature. The 20 resulting yellow oil was dissolved in ether (50ml) and saturated aqueous sodium bicarbonate was added to pH9. The organic solution was separated, washed with saturated aqueous sodium bicarbonate solution, water, brine and dried ( $MgSO_4$ ). Evaporation of the solvent left a yellow 25 oil which was crystallised from 2-propanol to give the

title compound (0.5g) mp 110-11°.

The compound of Example 113 was prepared using appropriate starting materials and the method of Example 112.

5 Example 113

Diethyl 2-(fluoromethyl)-1,4-dihydro-6-hydroxymethyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate  
mp 149-50°. (2-Propanol).

Example 114

10 Diethyl 2-cyano-6-(fluoromethyl)-1,4-dihydro-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

(a) Diethyl 2-(2,4-dinitrophenoxyiminomethyl)-6-(fluoromethyl)-1,4-dihydro-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

15 The compound of Example 74 (0.2g, 10.5mmoles) and 0-(2,4-dinitrophenyl)hydroxylamine (0.1g, 10.5mmoles) were dissolved in warm ethanol (5ml) and c. hydrochloric acid (1 drop) was added. The reaction mixture was allowed to cool to room temperature, and then in ice, and the resulting 20 solid filtered off (0.157g), mp 150-2°.

(b) Diethyl 2-cyano-6-(fluoromethyl)-1,4-dihydro-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate

The product of step (a) (0.45g, 0.8mmoles) was dissolved in 95% aqueous ethanol (20ml) by heating, and 25 then potassium hydroxide (10.16ml of 0.2M in 95% aqueous

ethanol) was added dropwise. The solution was heated at reflux for 3 hours and then the ethanol removed in vacuo. The residue was dissolved in water (75ml), 5% aqueous sodium hydroxide (6ml) and chloroform (100ml). The 5 aqueous layer was separated and extracted several times with chloroform. The combined extracts were washed with water, dried ( $MgSO_4$ ) and the solvent was removed in vacuo. The residue was crystallised from 2-propanol to give the title compound (0.19g) mp 147-8°(dec.).

10 Example 115

Diethyl 2,6-di-(fluoromethyl)-1,4-dihydro-4-(3-nitro-phenyl)-3,5-pyridinedicarboxylate

3-Nitrobenzaldehyde (1.51g, 10mmoles), ethyl 4-fluoro-3-oxo-butanoate (3g, 20mmoles) and aqueous 15 ammonia (1.1ml,  $d=0.88$ ) in ethanol (15ml) were heated at reflux for 14 hours; more aqueous ammonia (0.55ml) was added after 6 hours. The solvent was removed in vacuo and the residue was chromatographed on silica eluting with ether/petroleum ether (60-80°) mixtures and the product 20 obtained was recrystallised from 2-propanol to give the title compound as yellow crystals (0.4g) mp 113-4°.

Example 116

(+) 3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Diastereomer A (0.58g, from Example 57) was dissolved in acetonitrile (6ml) and formic acid (0.19ml) and zinc dust (0.6g) were added in turn. The reaction mixture was stirred for 2.5 hours and then cooled in ice while 5 chloroform (20ml) and water (20ml) were added. The aqueous layer was acidified with dilute hydrochloric acid; the organic layer was separated and the aqueous layer re-extracted with chloroform. The combined organic extracts were dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent removed 10 in vacuo to afford 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate.

The mono-acid was azeotroped once with carbon tetrachloride and then dissolved in ethyl acetate (10ml). 15 2-Propanol (0.7ml) and dicyclohexylcarbodiimide (1.75g) were added and the mixture stirred at room temperature overnight and then heated at  $60^\circ$  for 2 hours. The solvent was removed in vacuo and the residue chromatographed on silica eluting with methylene chloride, 20 followed by recrystallisation from hexane, to give the title compound (0.2g) mp  $124-5^\circ$   $[\alpha]_D^{24.5} +38.2^\circ$  (c 0.1 in ethanol).

Example 117

(-) 3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)  
25 -2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-

• pyridinedicarboxylate

Prepared as in Example 116, using diastereomer B from Example 57. Recrystallised from methanol/hexane mp 124-5°  $[\alpha]_D^{24}$  -42.3° (c 0.11 in ethanol).

5 Example 118

(+) 5-Cyclopentyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Prepared as in Example 116, using diastereomer A from 10 Example 57 and esterifying with cyclopentanol.

Re-crystallised from hexane mp 89-91°,  $[\alpha]_D^{24.5}$  +62.9° (c 0.1 in ethanol).

Example 119

(-) 5-Cyclopentyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate

Prepared as in Example 118, using diastereomer B from Example 57 and esterifying with cyclopentanol.

Examples of Intermediates

Example A

Methyl 4-fluoro-3-oxo-butanoate

Fluoroacetyl chloride (7.1g, 73mmoles) was added  
5 dropwise to a stirred solution of 2,2-dimethyl-1,3-dioxane-  
4,6-dione (10.65g, 74mmoles) and pyridine (16.85ml,  
210mmoles) in methylene chloride (75ml) keeping the  
temperature below 10°. After stirring for 16 hours at  
room temperature the solution was diluted with methylene  
10 chloride (100ml) and then washed with 1N hydrochloric acid  
(200ml) and water (100ml). The organic extract was dried  
( $\text{Na}_2\text{SO}_4$ ) and the solvent removed in vacuo. The  
residue was dissolved in methanol (150ml) and the solution  
heated at reflux for 2.5 hours. Removal of the solvent  
15 followed by distillation at 60-80° (bath temp)/14mm Hg  
gave methyl 4-fluoro-3-oxobutanoate (6.4g).

The compounds of Examples B and C were prepared using  
appropriate starting materials and the method of Example A.

Example B

20 1-Methylethyl 4-fluoro-3-oxobutanoate

Colourless oil, bp 100-120° (bath temp)/12mm Hg.

Example C

Tetrahydro-4H-pyran-4-yl 4-fluoro-3-oxobutanoate

Nmr ( $\text{CDCl}_3$ )  $\delta$  5.0(m, H), 4.9(d, 2H,  $J=48\text{Hz}$ ).

25 Example D

2-Methoxyethyl 4-fluoro-3-oxobutanoate

Ethyl 4-fluoro-3-oxobutanoate (2.1g) was heated at reflux in 2-methoxyethanol (10ml) for 3 hours. The solvent was removed in vacuo and the residue distilled to 5 give the title compound as a colourless oil (1.75g).

Nmr (CDCl<sub>3</sub>) δ 4.9 (d, 2H, J=48Hz), 3.4 (s, 3H).

The compounds of Examples E and F were prepared using appropriate starting materials and the method of Example D.

Example E10 2-Propoxyethyl 4-fluoro-3-oxobutanoate

Nmr (CDCl<sub>3</sub>) δ 4.9 (d, 2H, J=47Hz), 0.9 (t, 3H, J=7Hz).

Example F2-Phenoxyethyl 4-fluoro-3-oxobutanoate

Nmr (CDCl<sub>3</sub>) δ 7.5-6.9 (m, 5H), (4.9 d, 2H, J=48Hz).

15 Example GMethyl 3-amino-4-fluoro-2-butenoate

Ammonia was bubbled through a solution of methyl 4-fluoro-3-oxobutanoate (2.6g) in methanol (26ml) at 0° for 3 hours. After stirring overnight at room 20 temperature the solvent was removed in vacuo and the residue distilled (bp 100° at 20 mm Hg) to give the title compound (1.3g) Nmr (CDCl<sub>3</sub>) δ 4.9 (d, 2H, J=48Hz), 4.6 (s, H), (3.7 s, 3H).

The compounds of Examples H to J were prepared using 25 appropriate starting materials and the method of Example G.

Example HEthyl 3-amino-4-fluoro-2-butenoate

M<sup>+</sup> 147; nmr (D<sub>6</sub>-DMSO) δ 4.9 (d, 2H, J=46Hz),  
4.5 (s, H).

5 Example ITetrahydro-4H-pyran-4-yl 3-amino-2-butenoate

Colourless crystals mp 88-90°.

Example J1-Ethylpropyl 3-amino-2-butenoate

10 Pale yellow oil, bp 143-8°/12mm Hg.

Example K(S)-2,2,2-Trichloro-1-phenylethyl 3-oxobutanoate

Diketene (3.7ml, 47mmoles) was added slowly to a  
stirred mixture of (S)-alpha-(trichloromethyl)  
15 phenylmethanol (9.2g, 41mmoles) and triethylamine (0.05ml)  
kept at 80-90°. The mixture was maintained for 5 hours  
at 90°. The cooled reaction mixture was purified using  
HPLC eluting with methylene chloride/petroleum ether  
60-80° to give the title compound (11g) as an oil.

20 Nmr (CDCl<sub>3</sub>) δ 6.39 (s, H), 3.61 (s, 2H), 2.31 (s, 3H).

The compound of Example L was obtained by the same  
method.

Example L2,2,2-Trichloro-1-phenylethyl 3-oxobutanoate

25 Colourless solid, nmr (CDCl<sub>3</sub>) δ 6.39 (s, H), 3.61

• (s, 2H), 2.31 (s, 3H).

Example M

Tetrahydro-4H-pyran-4-yl 3-oxobutanoate

A solution of tetrahydro-4H-pyran-4-ol (1.6ml,  
5 16.8mmoles) and 5-acetyl-2,2-dimethyl-1,3-dioxane-4,6-dione (3.0g, 16.1mmoles) in dry benzene (50ml) was heated under reflux for 4 hours. The solvent was removed in vacuo and the residue distilled at 146-151°/14mm Hg to afford the title product as a colourless oil, 2.84g.

10 Nmr (CDCl<sub>3</sub>) δ 5.1 (m, H), 3.5 (s, 3H).

The esters of Examples N to R were prepared using appropriate starting materials and the method of Example M.

Example N

1-Ethylpropyl 3-oxobutanoate

15 Colourless oil, bp 128-38° (bath temp)/14mm Hg.

Example O

1-Methyl-1-phenylethyl 3-oxobutanoate

Colourless oil, bp 108-110° (bath temp)/0.03mm Hg.

Example P

1-Methylcyclopentyl 3-oxobutanoate

Colourless oil, bp 134-145° (bath temp)/14mm Hg.

Example Q

4-(1-Diphenylmethylazetidinyl) 3-oxobutanoate

Pale yellow oil. M<sup>+</sup> 323.

25 Example R

3-Oxetanyl 3-oxobutanoate

Pale yellow oil 165-70° (bath temp)/12mm Hg.

Example S1-Chloro-4-fluoro-2-(trifluoromethyl)benzene

5      4-Chloro-3-(trifluoromethyl)benzenamine (19.5g, 100mmoles), water (40ml) and c.hydrochloric acid (40ml) were heated with stirring on a steam bath until a white solid formed. The mixture was cooled (ice-salt bath) and a solution of sodium nitrite (7g, 101mmoles) in water 10 (15ml) was added over 15 mins. After stirring for a further hour at 0°, tetrafluoroboric acid (30g of 40% aqueous solution) was added dropwise over 15 minutes. After one hour the solid was filtered off, washed with water (10ml), methanol (30ml) and ether (30ml) and then 15 dried in vacuo. The dry compound was heated at 140°-180° until no more fumes were observed. The cooled residue was dissolved in ethyl acetate, washed with 5% aqueous sodium hydroxide, dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent was removed in vacuo. The residue was distilled 20 in vacuo (12mmHg, oven temperature 50°-55°) to give the sub-title compound as a colourless oil (7.5g).  $\text{M}^+$  200/198; nmr ( $\text{CDCl}_3$ ) δ 7.8-7.2 (m).

Example T2-Chloro-5-fluoro-3-(trifluoromethyl)benzaldehyde and

25      3-Chloro-6-fluoro-2-(trifluoromethyl)benzaldehyde

Butyl lithium (60.4ml of 1.6M in hexane, 97mmoles) was added with stirring over 1.5 hours under nitrogen to a solution of 1-chloro-4-fluoro-2-(trifluoromethyl)benzene (17.8g, 91mmoles) in dry tetrahydrofuran (150ml) at 5  $-73^{\circ}$ . After a further 1.5 hours at this temperature, N-methyl-N-phenylformamide (10.86ml, 90mmoles) in dry tetrahydrofuran (20ml) was added over 0.5 hours. After 15 minutes the reaction mixture was poured onto 10% aqueous sulphuric acid. The ethereal layer was separated, washed 10 with saturated sodium bicarbonate, dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent evaporated. The residue was purified by HPLC eluting with ethyl acetate/petroleum ether 60-80 $^{\circ}$  mixtures. 2-Chloro-5-fluoro-3-(trifluoromethyl)benzaldehyde (0.5g) was eluted first.

15  $\text{M}^+$  226/228; nmr ( $\text{CDCl}_3$ )  $\delta$  10.5 (s,H).

Further elution afforded 3-chloro-6-fluoro-2-(trifluoromethyl)benzaldehyde (8.35g).

$\text{M}^+$  226/228; nmr ( $\text{CDCl}_3$ )  $\delta$  10.5 (q,H).

Example U

20 2-Chloro-3-(trifluoromethyl) benzaldehyde

Butyl lithium (36.4ml of 1.6M in hexane) was added to a stirred solution at  $-65^{\circ}$  of 1-chloro-2-(trifluoromethyl)-benzene (10g) in dry tetrahydrofuran (100ml) over 20 mins. After stirring for 1.5 hours at 25  $-65^{\circ}$ , a solution of N-methyl-N-phenylformamide (6.85ml)

in tetrahydrofuran (30ml) was added over 1 hour. The reaction mixture was left at this temperature for 1.5 hours and then allowed to reach room temperature. It was then poured onto 10% sulphuric acid, extracted with ether and the organic extract was washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent removed in vacuo. The residue was distilled (20mmHg, oven temperature 100-125°); the distillate was cooled, filtered and the solid washed with petroleum ether (60-80°) to give the desired aldehyde (3.5g) as a colourless solid.

$\text{M}^+ 210/208$ , nmr ( $\text{CDCl}_3$ )  $\delta$  10.75 (s, H).

Example V

2,3-Dichloro-6-fluorobenzaldehyde

Butyl lithium (48ml of 1.6M in hexane, 52.3mmoles) was added with stirring over 1.5 hours under nitrogen to a solution of 1,2-dichloro-4-fluorobenzene (7.85g, 47.6mmoles) in dry tetrahydrofuran (120ml) at -68°. The solution was stirred at -68° for 2 hours and then N-methyl-N-phenylformamide (6.48ml) in dry tetrahydrofuran (15ml) was added over 1.5 hours. After a further 1.5 hours at -68°, the reaction mixture was poured into 10% aqueous sulphuric acid and ether. The ethereal layer was separated, washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and evaporated to give the desired aldehyde (8g).

$\text{M}^+ 196/194/192$ , nmr ( $\text{CDCl}_3$ )  $\delta$  10.5 (s, H).

Example W

	<u>% w/w</u>	<u>Range % w/w</u>
Compound of formula I	5	1-20
Microcystalline cellulose	50	10-80
5 Spray dried lactose	37.75	10-80
Magnesium stearate	1	0.25-2
Colloidal silicon dioxide	0.25	0.1-1
Cross linked sodium carboxy		
methyl cellulose	3	1-5
10 Hydroxypropylmethylcellulose		
(coating)	3	1-5

This formulation is made up as a direct compression tablet, or without compression or coating, may be filled into a gelatine capsule.

15 Example X

	<u>% w/w</u>	<u>Range % w/w</u>
Compound of formula I	5	1-20
Microcystalline cellulose	50	10-80
Lactose	35.75	10-80
20 Polyvinylpyrrolidone	2	1-5
Magnesium stearate	1	0.25-2
Colloidal silicon dioxide	0.25	0.1-1
Cross linked sodium carboxy		
methyl cellulose	3	1-5
25 Hydroxypropyl methyl cellulose		

(coating)

3

1-5

This formulation is made up as a granulate and then compressed into a tablet. Alternatively the granules may be filled into a gelatine capsule.

5

10

15

20

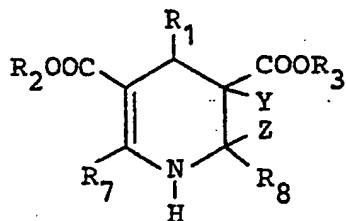
25

• What we claim is:-

1. A compound of formula I,

5

I



in which  $R_1$  represents benzofurazanyl, pyridyl or phenyl, the pyridyl or phenyl being substituted by one or 10 more of the groups halogen, nitro,  $-CN$ ,  $-OR_9$ ,  $-S(O)_pR_9$ , or alkyl Cl to 6 optionally substituted by halogen,

$p$  is 0, 1 or 2,

$R_2$  and  $R_3$ , which may be the same or different, 15 each represent hydrogen; alkyl Cl to 6 optionally substituted by one or more of the groups halogen, cyano,  $-XR_4$ ,  $-NR_5R_6$  or phenyl; cycloalkyl C3 to 8 optionally substituted by alkyl Cl to 6; a 4, 5 or 6 membered oxygen or nitrogen containing heterocyclic ring 20 which is optionally substituted by alkyl Cl to 6 the alkyl in turn optionally being substituted by one or more phenyl groups;

$R_5$  and  $R_6$ , which may be the same or different, 25 each represent alkyl Cl to 6 optionally substituted by phenyl,

Y and Z together form a bond, and additionally, when R<sub>8</sub> is an electron withdrawing group Y may be hydrogen and Z may be hydroxy,

one of R<sub>7</sub> and R<sub>8</sub> represents alkyl Cl to 6 and the 5 other represents -CONR<sub>10</sub>R<sub>11</sub>; -CSNH<sub>2</sub>; -C(=NH)SR<sub>9</sub>; -S(O)<sub>m</sub>R<sub>9</sub>; phenyl optionally substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; alkyl Cl to 6 substituted by halogen; or furanyl,

or R<sub>7</sub> and R<sub>8</sub> may be the same or different and 10 each represents phenyl optionally substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; amino; alkyl Cl to 6 substituted by halogen; -CN; -CH<sub>2</sub>OH; -CHO or -CH(OR<sub>9</sub>)<sub>2</sub>,

X is O or S,

15 m is 0 or 1,

R<sub>4</sub> is alkyl Cl to 6 or phenyl,

R<sub>9</sub> is alkyl Cl to 6,

R<sub>10</sub> and R<sub>11</sub> each independently represent hydrogen or alkyl Cl to 6, or together with the nitrogen atom to 20 which they are attached form a 5 or 6 membered heterocyclic ring,

provided that A) when R<sub>7</sub> is alkyl Cl to 6, Y and Z together form a bond, and

i) R<sub>1</sub> represents benzofurazanoyl then R<sub>8</sub> does 25 not represent -CF<sub>3</sub>, or

ii) when  $R_1$  represents 2-nitrophenyl, or 2-chlorophenyl and  $R_2$  and  $R_3$  are both ethyl, then  $R_8$  does not represent mono-chloromethyl,

iii) when  $R_1$  represents 3-nitrophenyl and  $R_2$  and 5  $R_3$  are both ethyl, then  $R_8$  does not represent unsubstituted phenyl,

B) when neither of  $R_7$  and  $R_8$  is alkyl Cl to 6, Y and Z together form a bond and

iv)  $R_2$  and  $R_3$  are both ethyl then  $R_7$  and  $R_8$  10 are not both  $-CF_3$ , or

v) one of  $R_7$  or  $R_8$  is amino then the other is not phenyl or amino, or

vi) one of  $R_7$  or  $R_8$  is  $-CN$ ,  $-CH_2OH$ ,  $-CHO$  or  $-CH(OR_9)_2$  then the other is not  $-CN$ ,  $-CH_2OH$ ,  $-CHO$  or 15  $-CH(OR_9)_2$ , and

C) both of  $R_7$  and  $R_8$  are not optionally substituted phenyl,

and pharmaceutically acceptable acid addition salts of those compounds containing a basic nitrogen atom.

20 2. A compound according to Claim 1, wherein

$R_1$  is nitrophenyl; (trifluoromethyl)phenyl; mono- or poly-fluorophenyl; mono- or poly-chlorophenyl; chloro- and/or fluoro-(trifluoromethyl)phenyl; (alkylthio)pyridyl; alkyl- and/or chloro- and/or alkoxy-nitrophenyl; mixed

25 chloro- and fluoro-phenyl; mono- or poly- alkoxy-phenyl;

alkylphenyl; (alkylthio)phenyl; (alkylsulphonyl)phenyl, or 4-benzofurazanyl,

R<sub>2</sub> and R<sub>3</sub> are selected from alkyl Cl to 4; 2-alkoxy Cl to 3 - ethyl; 2-phenoxy- ethyl; cycloalkyl C4 5 to 6 optionally substituted by methyl; an oxetanyl, azetidinyl, piperidinyl or tetrahydropyranyl ring optionally substituted by phenylmethyl or diphenylmethyl; alkyl Cl to 4 - (phenylmethyl)aminoethyl; cyano- or alkyl Cl to 4 - thio- alkyl Cl to 4; phenyl alkyl Cl to 4 or 10 -CH(C<sub>6</sub>H<sub>5</sub>)CCl<sub>3</sub>,

R<sub>7</sub> is methyl, and

R<sub>8</sub> is chloro- or fluoro- alkyl Cl or 2, -CSNH<sub>2</sub>, -CON(alkyl Cl to 4)<sub>2</sub>, -COMorpholino, -COimidazolyl, -C(=NH)S-alkyl Cl to 4, -S-alkyl Cl to 4, -S(O)-alkyl Cl 15 to 4, or phenyl substituted by one or two chlorine, nitro, methoxy or methyl groups.

3. A compound according to Claim 1, wherein R<sub>1</sub> is phenyl carrying a 2-nitro or a 2-CF<sub>3</sub> group or at least two substituents selected from chloro, fluoro, alkyl Cl to 20 6, -CF<sub>3</sub> and nitro; R<sub>2</sub> is alkyl Cl to 6, or is oxetan-3-yl, R<sub>3</sub> is alkyl Cl to 6, R<sub>7</sub> is alkyl Cl to 6, R<sub>8</sub> is fluoromethyl, and Y and Z together form a bond.

4. A compound according to Claim 1, wherein R<sub>1</sub> is phenyl carrying at least two substituents selected from 25 chloro, fluoro, -CF<sub>3</sub>, methyl and nitro, R<sub>3</sub> and R<sub>7</sub> are both methyl, R<sub>8</sub> is -CH<sub>2</sub>F, R<sub>2</sub> is isopropyl or

- cyclopentyl and Y and Z together form a bond.
- 5. A compound according to Claim 1, wherein R<sub>1</sub> represents benzofurazanyl, pyridyl or phenyl, the pyridyl or phenyl being substituted by one or more of the groups 5 halogen, nitro, trihalomethyl or -SR<sub>9</sub>; R<sub>2</sub> and R<sub>3</sub> each represent alkyl Cl to 6, -(CH<sub>2</sub>)<sub>n</sub> R<sub>4</sub>, -(CH<sub>2</sub>)<sub>n</sub>CN, -CH(C<sub>6</sub>H<sub>5</sub>)CCl<sub>3</sub> or -(CH<sub>2</sub>)<sub>n</sub>NR<sub>5</sub>R<sub>6</sub>; Y and Z together form a bond; one of R<sub>7</sub> and R<sub>8</sub> represents alkyl Cl to 6 and the other represents 10 -CONR<sub>10</sub>R<sub>11</sub>; -CSNH<sub>2</sub>; -C(=NH)SR<sub>9</sub>; -S(O)<sub>m</sub>R<sub>9</sub>; phenyl substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; or alkyl Cl to 6 substituted by halogen; R<sub>4</sub> and R<sub>9</sub> are each alkyl Cl to 15 6; R<sub>10</sub> and R<sub>11</sub> each represent hydrogen or alkyl Cl to 6, n is 2, 3 or 4 and provisos i) and ii) apply.
- 6. 3-Methyl 5-(1-methylethyl) 4-(3-chloro-6-fluoro-2-(trifluoromethyl)phenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate.
- 7. 3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate, 20  
3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-methyl-3-nitrophenyl)-3,5-pyridinedicarboxylate,
- 25 5-Cyclopentyl 3-methyl 4-(2,3-dichlorophenyl)-2-

- (fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,
- 3-Methyl 5-(1-methylethyl) 4-(2-chloro-3-nitrophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,
- 5 3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-4-(2-fluoro-6-(trifluoromethyl)phenyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,
- 3-Methyl 5-(1-methylethyl) 4-(2,3-dichloro-6-fluorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,
- 10 5-Ethyl 3-methyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- 3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- 15 3-Methyl 5-(2-methylpropyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- 3-Methyl 5-(2-methylpropyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- 20 3-Ethyl 5-methyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(trifluoromethyl)phenyl)-3,5-pyridinedicarboxylate,
- 25 Diethyl 4-(4-benzofurazanyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

- Dimethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-  
-(2,3,4,5,6-pentafluorophenyl)-3,5-pyridinedicarboxylate,
- 5-Methyl 3-(1-methylethyl) 2-(fluoromethyl)-1,4-  
dihydro-6-methyl-4-(3-nitrophenyl)-3,5-  
5 pyridinedicarboxylate,
- 5-Ethyl 3-methyl 4-(2,3-dichlorophenyl)-2-  
(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate,
- Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-  
10 (2-(methylthio)-3-pyridyl)-3,5-pyridinedicarboxylate,
- 3-Methyl 5-(2-(methyl(phenylmethyl)amino)ethyl) 2-  
(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-  
pyridinedicarboxylate oxalate,
- 5-(2-Methoxyethyl) 3-(1-methylethyl) 4-(2,3-  
15 dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate,
- 5-(2-Cyanoethyl) 3-(1-methylethyl) 2-(fluoromethyl)  
-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-  
pyridinedicarboxylate,
- 20 3-(1-Methylethyl) 5-(2-(methylthio)ethyl) 2-  
(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-  
pyridinedicarboxylate,
- 3-Methyl 5-(1-methylethyl) 4-(2-chloro-5-nitrophenyl)  
-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridine-  
25 dicarboxylate,

3-Ethyl 5-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-5 dihydro-6-methyl-4-(2-methyl-5-nitrophenyl)-3,5-pyridinedicarboxylate,

3-(2-Methoxyethyl) 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

10 5-(2-Methoxyethyl) 3-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 4-(2-chloro-3-(trifluoromethyl)phenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-15 3,5-pyridinedicarboxylate,

5-(1-Methylethyl) 3-(tetrahydro-4H-pyran-4-yl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

5-(1-Methylethyl) 3-(2-phenoxyethyl) 2-(fluoromethyl)-20 -1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

5-Methyl 3-(tetrahydro-4H-pyran-4-yl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

25 5-Cyclohexyl 3-methyl 4-(2,3-dichlorophenyl)-2-

• (fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate,

5-Cyclopentyl 3-methyl 2-(fluoromethyl)-1,4-dihydro-6-  
methyl-4-(2-methyl-3-nitrophenyl)-3,5-  
5 pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 4-(2,3-dimethoxyphenyl)-2-  
(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate,

3-Methyl 5-(tetrahydro-4H-pyran-4-yl) 4-(2,3-  
10 dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
pyridinedicarboxylate,

5-Cyclopentyl 3-methyl 2-(fluoromethyl)-1,4-dihydro-6-  
methyl-4-(2-(trifluoromethyl)phenyl)-3,5-  
pyridinedicarboxylate,

15 5-Cyclopentyl 3-methyl 4-(3-chloro-6-fluoro-2-  
(trifluoromethyl)phenyl)-2-(fluoromethyl)-1,4-dihydro-6-  
methyl-3,5-pyridinedicarboxylate,

5-(1-Ethylpropyl) 3-methyl 4-(2,3-dichlorophenyl)-2-  
(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
20 pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-  
dihydro-4-(2-methoxy-3-nitrophenyl)-6-methyl-3,5-  
pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-  
25 dihydro-6-methyl-4-(2-(trifluoromethyl)phenyl)-3,5-

pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-nitrophenyl)-3,5-

pyridinedicarboxylate,

5 3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-4-(2-fluorophenyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-methylphenyl)-3,5-

10 pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 4-(2-chlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-

pyridinecarboxylate,

15 3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(methylthio)phenyl)-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(2-(methylsulphonyl)phenyl)-3,5-pyridinedicarboxylate,

20 3-Methyl 5-(1-methylethyl) 4-(3-chloro-2-methylphenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 4-(2,3-dimethylphenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
25 pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 4-(3-cyanophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

5 3-Methyl 5-(1-methylethyl) 4-(3-chlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(trifluoromethyl)-3,5-pyridinedicarboxylate,

10 3-Ethyl 5-methyl 4-(2,3-dichlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-2-(trifluoromethyl)-3,5-pyridinedicarboxylate,

15 Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(pentafluoroethyl)-3,5-pyridinedicarboxylate,

5-Cyclobutyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

20 3-Methyl 5-(3-oxetanyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(trichloromethyl)-3,5-pyridinedicarboxylate,

25 3-Methyl 5-((S)-2,2,2-trichloro-1-phenylethyl) 4-(2,3-

- dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,
- 3-Methyl 5-(2,2,2-trichloro-1-phenylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-  
5 pyridinedicarboxylate,
- Diethyl 2-(difluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- Diethyl 1,4-dihydro-2-methyl-6-methylthio-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- 10 Diethyl 1,4-dihydro-2-(4-methoxyphenyl)-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- Diethyl 2-(dichloromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,
- Diethyl 1,4-dihydro-2-methyl-6-phenyl-4-(2-(trifluoromethyl)phenyl)-3,5-pyridinedicarboxylate,
- 15 5-Methyl 3-(1-methylethyl) 4-(4-benzofurazanyl)-1,4-dihydro-2-methyl-6-phenyl-3,5-pyridinedicarboxylate,
- 5-Methyl 3-(1-methylethyl) 1,4-dihydro-2-methyl-6-phenyl-4-(2-(trifluoromethyl)phenyl)-3,5-pyridinedi-  
20 carboxylate,
- 5-Ethyl 3-methyl 4-(2,3-dichlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-2-phenyl-3,5-pyridinedicarboxylate,
- 25 Diethyl 4-(4-benzofurazanyl)-2-diethoxymethyl-1,4,5,6-tetrahydro-6-hydroxy-6-(trifluoromethyl)-3,5-

• pyridinedicarboxylate,

5-(1-(Diphenylmethyl)-3-azetidinyl) 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

5 3-Methyl 5-(1-(phenylmethyl)-4-piperidinyl)

4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

5-(1,1-Dimethylethyl) 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-

10 pyridinedicarboxylate,

3-Methyl 5-(1-methyl-1-phenylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylcyclopentyl) 4-(2,3-

15 dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate,

3-Methyl 5-(2,2,2-trichloro-1-phenylethyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

20 Diethyl 2-(fluoromethyl)-6-formyl-1,4-dihydro-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 4-(4-benzofurazanyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-2-phenyl-3,5-pyridinedicarboxylate,

25 Diethyl 2-amino-6-(fluoromethyl)-1,4-dihydro-4-

• (3-nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 2-(fluoromethyl)-1,4,5,6-tetrahydro-6-hydroxy-  
4-(3-nitrophenyl)-6-phenyl-3,5-pyridinedicarboxylate,  
Diethyl 2-(fluoromethyl)-1,4-dihydro-4-

5 (3-nitrophenyl)-6-phenyl-3,5-pyridinedicarboxylate,  
3-Ethyl 5-methyl 4-(2,3-dichlorophenyl)-1,4-dihydro-2-  
methyl-6-phenyl-3,5-pyridinedicarboxylate,  
Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-  
(4-nitrophenyl)-3,5-pyridinedicarboxylate,

10 Diethyl 2-(3,4-dichlorophenyl)-1,4-dihydro-6-methyl  
-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 2-(4-chlorophenyl)-1,4-dihydro-6-methyl-4-(3-  
nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-

15 (trifluoromethyl)-3,5-pyridinedicarboxylate,  
Diethyl 2-(3-chlorophenyl)-1,4-dihydro-6-methyl-  
4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-  
(pentafluoroethyl)-3,5-pyridinedicarboxylate,

20 5-Ethyl 3-methyl 4-(2,3-dichlorophenyl)-1,4-  
dihydro-2-methyl-6-(trifluoromethyl)-3,5-  
pyridinedicarboxylate,  
Diethyl 4-(4-benzofurazanyl)-2-(diethoxymethyl)-1,4-  
dihydro-6-(trifluoromethyl)-3,5-pyridinedicarboxylate,

25 Diethyl 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-

• (trichloromethyl)-3,5-pyridinedicarboxylate,  
Diethyl 1,4-dihydro-2-methyl-6-(methylsulphinyl)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 2-aminocarbonyl-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
5 Diethyl 2-(dimethylaminocarbonyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 1,4-dihydro-2-(1H-imidazol-1-ylcarbonyl)-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
10 Diethyl 1,4-dihydro-2-methyl-6-(4-morpholinylcarbonyl)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 2-(aminothioxomethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
15 Diethyl 1,4-dihydro-2-(imino(methylthio)methyl)-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate hydroiodide,  
Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
20 Di-(2-propoxyethyl) 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,  
Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-(4-nitrophenyl)-3,5-pyridinedicarboxylate,  
25 5-Methyl 3-(1-methylethyl) 1,4-dihydro-2-methyl-4-(3-nitrophenyl)-6-phenyl-3,5-pyridinedicarboxylate,

Diethyl 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-phenyl-3,5-pyridinedicarboxylate,

Diethyl 2-(3,4-dichlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

5 Diethyl 2-(4-chlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

Diethyl 1,4-dihydro-2-methyl-6-(4-methylphenyl)-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

10 3-Methyl 5-(1-methylethyl) 1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-2-phenyl-3,5-pyridinedicarboxylate,

Diethyl 2-(3-chlorophenyl)-1,2,3,4-tetrahydro-2-hydroxy-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

15 Diethyl 2-(2-furanyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 2-(difluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

20 5-Cyclopentyl 3-methyl 2-(difluoromethyl)-1,4-dihydro-6-methyl-4-(2-methyl-3-nitrophenyl)-3,5-pyridinedicarboxylate,

3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(difluoromethyl)-1,4-dihydro-6-methyl-3,5-

25

pyridinedicarboxylate,

Diethyl 2-(fluoromethyl)-1,4-dihydro-6-methyl-4-

(3-nitrophenyl)-3,5-pyridinedicarboxylate,

3-(2-Methoxyethyl) 5-(1-methylethyl) 4-(2,3-

5 dichlorophenyl)-2-(difluoromethyl)-1,4-dihydro-6-methyl-

3,5-pyridinedicarboxylate,

3-(2-Methoxyethyl) 5-(1-methylethyl) 2-

(difluoromethyl)-1,4-dihydro-6-methyl-4-(3-nitrophenyl)

-3,5-pyridinedicarboxylate,

10 Diethyl 4-(4-benzofurazanyl)-2-formyl-1,4-dihydro-6-

(trifluoromethyl)-3,5-pyridinedicarboxylate,

Diethyl 4-(4-benzofurazanyl)-1,4-dihydro-2-

(hydroxymethyl)-6-trifluoromethyl-3,5-pyridinedicarboxylate,

15 Diethyl 2-(fluoromethyl)-1,4-dihydro-6-hydroxymethyl

-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

Diethyl 2-cyano-6-(fluoromethyl)-1,4-dihydro-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

20 Diethyl 2,6-di-(fluoromethyl)-1,4-dihydro-4-(3-nitrophenyl)-3,5-pyridinedicarboxylate,

(+) 3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-

pyridinedicarboxylate,

(-) 3-Methyl 5-(1-methylethyl) 4-(2,3-dichlorophenyl)-

25 -2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-

pyridinedicarboxylate,

(+) 5-Cyclopentyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate, or

5 (-) 5-Cyclopentyl 3-methyl 4-(2,3-dichlorophenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate.

8. A pharmaceutical formulation containing a compound according to any one of the preceding claims in admixture 10 with a pharmaceutically acceptable adjuvant, diluent or carrier.

9. The use of a compound according to Claim 1 without proviso ii) as a pharmaceutical.

10. A process for the production of a compound of formula 15 I, as defined in Claim 1, or a pharmaceutically acceptable acid addition salt thereof, which comprises

a) reaction of a compound of formula II,

$R_1\text{CHO}$  II

with compounds of formulae III and IV,

20  $R_2\text{OOCCH}=\text{C}(R_7)\text{NH}_2$  III

$R_3\text{OOCCH}_2\text{COR}_8$  IV

in which formulae  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_7$  and  $R_8$  are as defined in Claim 1,

b) reaction of a compound of formula V,

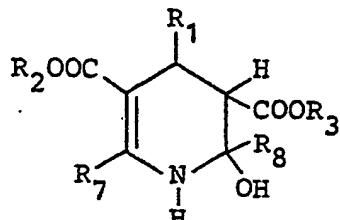
25  $R_1\text{CH}=\text{C}(\text{COOR}_3)\text{COR}_8$  V

in which  $R_1$ ,  $R_3$  and  $R_8$  are as defined in

Claim 1,

with a compound of formula III,

c) production of a compound of formula I in which Y and  
 5 Z together form a bond by dehydration of a compound of  
 formula VII,



VII

10

in which  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_7$  and  $R_8$  are as  
 defined in Claim 1,

d) production of a compound of formula I in which m is 1  
 or p is 1 or 2 by selective oxidation of a corresponding  
 15 compound of formula I in which m is 0, or p is 0 or 1  
 respectively,

e) production of a compound of formula I in which one of  
 $R_7$  and  $R_8$  is  $-CONR_{10}R_{11}$  by reaction of an acid  
 halide, imidazole or a mixed anhydride of a corresponding  
 20 compound of formula I in which one of  $R_7$  and  $R_8$  is  
 $-COOH$  with a compound  $HNR_{10}R_{11}$  in which  $R_{10}$  and  
 $R_{11}$  are as defined in Claim 1, or, when the group  
 $-NR_{10}R_{11}$  in the product represents an imidazole,  
 reacting the free carboxylic acid of formula I with  
 25  $N,N'$ -carbonyldiimidazole,

f) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CSNH<sub>2</sub> by reaction of a corresponding compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CN with hydrogen sulphide,

5 g) isomerising a 3,4-dihydropyridine to a corresponding compound of formula I,

h) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -C(=NH)SR<sub>9</sub> by reaction of a corresponding compound of formula I in which one of R<sub>7</sub>

10 and R<sub>8</sub> is -CSNH<sub>2</sub> with a compound R<sub>9</sub>-hal, in which R<sub>9</sub> is as defined in Claim 1 and hal is a halogen atom,

i) reaction of a compound of formula IV with ammonia and a compound of formula VI,



VI

15 or reaction of a compound of formula V with ammonia and a compound of formula VII,



VII

or reaction of compounds of formulae II, IV and VII with ammonia,

20 in which formulae R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>7</sub> and R<sub>8</sub> are as defined in Claim 1,

j) production of a compound of formula I in which Y and Z together form a bond and one or both of R<sub>7</sub> and R<sub>8</sub> is -CHF<sub>2</sub> or -CH<sub>2</sub>F by reaction of a corresponding compound

25 of formula I in which Y and Z together form a bond and one

- or both of  $R_7$  and  $R_8$  is  $-CHO$  or  $-CH_2L$ , where  $L$  is  $-OH$  or a good leaving group, respectively with a fluorinating agent,
- 5 k) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-CHO$  by selective hydrolysis of a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is  $-CH(OR_9)_2$ ,
- 10 l) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-CH_2OH$  by selective reduction of a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is  $-CHO$ ,
- m) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-CN$  by elimination of  $ROH$  from a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is  $-CH=NOR$ , and  $-OR$  is a good leaving group,
- 15 n) production of a compound of formula I in which at least one of  $R_2$  and  $R_3$  is hydrogen by reductive cleavage or hydrolysis of a corresponding compound of formula I in which at least one of  $R_2$  and  $R_3$  is other than hydrogen,
- 20 o) production of a compound of formula I in which at least one of  $R_2$  and  $R_3$  is other than hydrogen by esterification or transesterification of a corresponding compound of formula I in which at least one of  $R_2$  and  $R_3$  is hydrogen or is a group  $R_2$  or  $R_3$  other than
- 25  $R_3$  is hydrogen or is a group  $R_2$  or  $R_3$  other than

- that desired in the end product, or
- p) production of an optical isomer of a compound of formula I by resolution of a mixture of optical isomers of the compound,

5 and where desired or necessary converting the resulting compound of formula I to a pharmaceutically acceptable acid addition salt thereof or vice versa.

11. A compound of formula VII as defined in Claim 1.

12. A compound  $R_1\text{CHO}$  in which  $R_1$  is

10 2-chloro-3-trifluoromethyl phenyl or phenyl substituted by three substituents selected from chloro-, fluoro- and  $-CF_3$ .

13. 3-Chloro-6-fluoro-2-(trifluoromethyl)benzaldehyde.

15

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Our Ref: 83/11519/CBC/MJ

16th August 1984

European Patent Office  
P.B. 5818  
N.L. 2280HV  
Rijswijk ZH  
The Hague  
Netherlands

The request for correction is allowed under  
R. 88 EPC / with the exception of the deleted  
points/.

12.09.84

THE HAGUE,  
RECEIVING SECTION

*W. Wenzel*

Dear Sirs,

EUROPEAN PATENT APPLICATION NO. 84302566.9  
FISON'S PLC - OUR REFERENCE 83/11519

The Applicants wish to make the following amendments to this  
case at a suitable stage of its prosecution and request that  
they be made by the Office after the Search Report is sent.

Page 6 lines 10, 11 and 12 and Page 98 lines 16, 17 and  
18 - change 'VII' to 'VIII'.

Page 100 line 8 - change 'Claim 1' to 'Claim 10'.

Page 36 line 18 and Page 88 line 13 - change  
'pyridinecarboxylate' to 'pyridinedicarboxylate'.

Page 3 lines 7, 17, 19 and 21, Page 80 line 24,  
Page 81 lines 9, 11 and 13, - insert 'when' after 'i)',  
'iv)', 'v)' and 'vi)' respectively.

Page 80 line 24 - correct the spelling of 'benzofurazanyl'.

~~Page 95 between lines 23 and 24 add:-~~

~~"3-methyl 4-(2,3-disubstitutedphenyl)-2-(fluoromethyl)-1,  
4-dihydro-6-methyl-3, 5-pyridinedicarboxylate,"~~  
(cf page 68 line 10).

We would ask you please to acknowledge receipt of this letter  
by returning the enclosed copy in the envelope provided.

Yours faithfully,

  
C.B. CRAIG

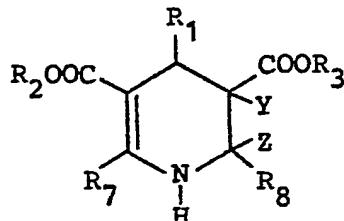
European Patent Attorney

EPA-EPO-OEB DG 1 Rijswijk
Empfang bestätigt Receipt acknowledged Accusé réception
20 AUG. 1984
R. P. A. SEWALT - 3103

What we claim is:-

1. A process for the production of a compound of formula I,

5



I

in which R<sub>1</sub> represents benzofurazanyl, pyridyl or 10 phenyl, the pyridyl or phenyl being substituted by one or more of the groups halogen, nitro, -CN, -OR<sub>9</sub>, -S(O)<sub>p</sub>R<sub>9</sub>, or alkyl C1 to 6 optionally substituted by halogen,

p is 0, 1 or 2,

15 R<sub>2</sub> and R<sub>3</sub>, which may be the same or different, each represent hydrogen; alkyl C1 to 6 optionally substituted by one or more of the groups halogen, cyano, -XR<sub>4</sub>, -NR<sub>5</sub>R<sub>6</sub> or phenyl; cycloalkyl C3 to 8 optionally substituted by alkyl C1 to 6; a 4, 5 or 6 20 membered oxygen or nitrogen containing heterocyclic ring which is optionally substituted by alkyl C1 to 6 the alkyl in turn optionally being substituted by one or more phenyl groups;

R<sub>5</sub> and R<sub>6</sub>, which may be the same or different, 25 each represent alkyl C1 to 6 optionally substituted by

phenyl,

Y and Z together form a bond, and additionally, when R<sub>8</sub> is an electron withdrawing group Y may be hydrogen and Z may be hydroxy,

5 one of R<sub>7</sub> and R<sub>8</sub> represents alkyl Cl to 6 and the other represents -CONR<sub>10</sub>R<sub>11</sub>; -CSNH<sub>2</sub>; -C(=NH)SR<sub>9</sub>; -S(O)<sub>m</sub>R<sub>9</sub>; phenyl optionally substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; alkyl Cl to 6 substituted by halogen; or furanyl,

10 or R<sub>7</sub> and R<sub>8</sub> may be the same or different and each represents phenyl optionally substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; amino; alkyl Cl to 6 substituted by halogen; -CN; -CH<sub>2</sub>OH; -CHO or -CH(OR<sub>9</sub>)<sub>2</sub>,

15 X is O or S,

m is 0 or 1,

R<sub>4</sub> is alkyl Cl to 6 or phenyl,

R<sub>9</sub> is alkyl Cl to 6,

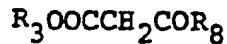
R<sub>10</sub> and R<sub>11</sub> each independently represent hydrogen

20 or alkyl Cl to 6, or together with the nitrogen atom to which they are attached form a 5 or 6 membered heterocyclic ring,

provided that A) when R<sub>7</sub> is alkyl Cl to 6, Y and Z together form a bond, and

25 i) R<sub>1</sub> represents benzofurazanoyl then R<sub>8</sub> does

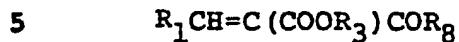




IV

in which formulae  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_7$  and  $R_8$  are as defined above,

b) reaction of a compound of formula V,

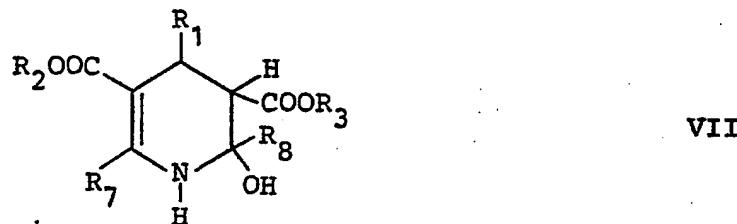


V

in which  $R_1$ ,  $R_3$  and  $R_8$  are as defined above,  
with a compound of formula III,

c) production of a compound of formula I in which Y and Z together form a bond by dehydration of a compound of

10 formula VII,



15 in which  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_7$  and  $R_8$  are as defined above,

d) production of a compound of formula I in which m is 1 or p is 1 or 2 by selective oxidation of a corresponding compound of formula I in which m is 0, or p is 0 or 1

20 respectively,

e) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-CONR_{10}R_{11}$  by reaction of an acid halide, imidazole or a mixed anhydride of a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is

25  $-COOH$  with a compound  $HNR_{10}R_{11}$  in which  $R_{10}$  and

R<sub>11</sub> are as defined above, or, when the group -NR<sub>10</sub>R<sub>11</sub> in the product represents an imidazole, reacting the free carboxylic acid of formula I with N,N'-carbonyldiimidazole,

5 f) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CSNH<sub>2</sub> by reaction of a corresponding compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CN with hydrogen sulphide,

g) isomerising a 3,4-dihydropyridine to a corresponding compound of formula I,

10 h) production of a compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -C(=NH)SR<sub>9</sub> by reaction of a corresponding compound of formula I in which one of R<sub>7</sub> and R<sub>8</sub> is -CSNH<sub>2</sub> with a compound R<sub>9</sub>-hal, in which

15 R<sub>9</sub> is as defined above and hal is a halogen atom,

i) reaction of a compound of formula IV with ammonia and a compound of formula VI,

R<sub>1</sub>CH=C(COOR<sub>2</sub>)COR<sub>7</sub> VI

or reaction of a compound of formula V with ammonia and a

20 compound of formula VII,

R<sub>2</sub>OOCCH<sub>2</sub>COR<sub>7</sub> VII

or reaction of compounds of formulae II, IV and VII with ammonia,

in which formulae R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>7</sub> and R<sub>8</sub> are

25 as defined above,

- j) production of a compound of formula I in which Y and Z together form a bond and one or both of  $R_7$  and  $R_8$  is  $-\text{CHF}_2$  or  $-\text{CH}_2\text{F}$  by reaction of a corresponding compound of formula I in which Y and Z together form a bond and one or both of  $R_7$  and  $R_8$  is  $-\text{CHO}$  or  $-\text{CH}_2\text{L}$ , where L is  $-\text{OH}$  or a good leaving group, respectively with a fluorinating agent,
- 5 k) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CHO}$  by selective hydrolysis of a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CH}(\text{OR}_9)_2$ ,
- 10 l) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CH}_2\text{OH}$  by selective reduction of a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CHO}$ ,
- 15 m) production of a compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CN}$  by elimination of ROH from a corresponding compound of formula I in which one of  $R_7$  and  $R_8$  is  $-\text{CH=NOR}$ , and  $-\text{OR}$  is a good leaving group,
- 20 n) production of a compound of formula I in which at least one of  $R_2$  and  $R_3$  is hydrogen by reductive cleavage or hydrolysis of a corresponding compound of formula I in which at least one of  $R_2$  and  $R_3$  is other than hydrogen,
- 25 o) production of a compound of formula I in which at

- least one of  $R_2$  and  $R_3$  is other than hydrogen by esterification or transesterification of a corresponding compound of formula I in which at least one of  $R_2$  and  $R_3$  is hydrogen or is a group  $R_2$  or  $R_3$  other than
- 5 that desired in the end product, or
  - p) production of an optical isomer of a compound of formula I by resolution of a mixture of optical isomers of the compound,
- and where desired or necessary converting the
- 10 resulting compound of formula I to a pharmaceutically acceptable acid addition salt thereof or vice versa.

2. A process according to Claim 1, wherein

- $R_1$  is nitrophenyl; (trifluoromethyl)phenyl; mono- or poly-fluorophenyl; mono- or poly-chlorophenyl; chloro-
- 15 and/or fluoro-(trifluoromethyl)phenyl; (alkylthio)pyridyl; alkyl- and/or chloro- and/or alkoxy-nitrophenyl; mixed chloro- and fluoro-phenyl; mono- or poly- alkoxy-phenyl; alkylphenyl; (alkylthio)phenyl; (alkylsulphonyl)phenyl, or 4-benzofurazanyl,
- 20  $R_2$  and  $R_3$  are selected from alkyl Cl to 4; 2-alkoxy Cl to 3 - ethyl; 2-phenoxy- ethyl; cycloalkyl C4 to 6 optionally substituted by methyl; an oxetanyl, azetidinyl, piperidinyl or tetrahydropyranyl ring optionally substituted by phenylmethyl or diphenylmethyl;
- 25 alkyl Cl to 4 - (phenylmethyl)aminoethyl; cyano- or alkyl

- Cl to 4 - thio- alkyl Cl to 4; phenyl alkyl Cl to 4 or  $-\text{CH}(\text{C}_6\text{H}_5)\text{CCl}_3$ , .
  - R<sub>7</sub> is methyl, and
  - R<sub>8</sub> is chloro- or fluoro- alkyl Cl or 2, -CSNH<sub>2</sub>,
- 5 -CON(alkyl Cl to 4)<sub>2</sub>, -COMorpholino, -COimidazolyl, -C(=NH)S-alkyl Cl to 4, -S-alkyl Cl to 4, -S(O)-alkyl Cl to 4, or phenyl substituted by one or two chlorine, nitro, methoxy or methyl groups.
- 3. A process according to Claim 1, wherein R<sub>1</sub> is
- 10 phenyl carrying a 2-nitro or a 2-CF<sub>3</sub> group or at least two substituents selected from chloro, fluoro, alkyl Cl to 6, -CF<sub>3</sub> and nitro; R<sub>2</sub> is alkyl Cl to 6, or is oxetan -3-yl, R<sub>3</sub> is alkyl Cl to 6, R<sub>7</sub> is alkyl Cl to 6, R<sub>8</sub> is fluoromethyl, and Y and Z together form a bond.
- 15 4. A process according to Claim 1, wherein R<sub>1</sub> is phenyl carrying at least two substituents selected from chloro, fluoro, -CF<sub>3</sub>, methyl and nitro, R<sub>3</sub> and R<sub>7</sub> are both methyl, R<sub>8</sub> is -CH<sub>2</sub>F, R<sub>2</sub> is isopropyl or cyclopentyl and Y and Z together form a bond.
- 20 5. A process according to Claim 1, wherein R<sub>1</sub> represents benzofurazanyl, pyridyl or phenyl, the pyridyl or phenyl being substituted by one or more of the groups halogen, nitro, trihalomethyl or -SR<sub>9</sub>; R<sub>2</sub> and R<sub>3</sub> each represent alkyl Cl to 6, -(CH<sub>2</sub>)<sub>n</sub>R<sub>4</sub>,
- 25 -(CH<sub>2</sub>)<sub>n</sub>CN, -CH(C<sub>6</sub>H<sub>5</sub>)CCl<sub>3</sub> or -(CH<sub>2</sub>)<sub>n</sub>

- $NR_5R_6$ ; Y and Z together form a bond; one of  $R_7$  and  $R_8$  represents alkyl Cl to 6 and the other represents  $-CONR_{10}R_{11}$ ;  $-CSNH_2$ ;  $-C(=NH)SR_9$ ;  $-S(O)_mR_9$ ; phenyl substituted by one or more of alkyl Cl to 6, halogen, alkoxy Cl to 6 or nitro; or alkyl Cl to 6 substituted by halogen;  $R_4$  and  $R_9$  are each alkyl Cl to 6;  $R_{10}$  and  $R_{11}$  each represent hydrogen or alkyl Cl to 6, n is 2, 3 or 4 and provisos i) and ii) apply.
- 5. A process according to Claim 1, wherein the compound of formula I is 3-Methyl 5-(1-methylethyl) 4-(3-chloro-6-fluoro-2-(trifluoromethyl)phenyl)-2-(fluoromethyl)-1,4-dihydro-6-methyl-3,5-pyridinedicarboxylate.

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